

A  
T H E S I S  
O N  
B U B O N I C P L A G U E  
B Y  
D. N. P. DATTA.

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## P R E F A C E.

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I have divided this Thesis into ~~the~~ 3 parts for the sake of clearness.

In Part I. I have considered the subject of Bubonic Plague generally, commenting from my own experience as much as possible on points that came under my observation during the Epidemic of 1897 - 98 in the Jullandhar and Hushiarpur Districts in the Panjab.

In Part II., I have stated in a collective form the results of my own work and experience in the Hushiarpur District, where I was in sole medical charge of the Anti-plague operations from 20th October 1897 to 21st February 1898. Thereafter and up to the 1st of June 1898, my duties were simply to inspect non-infected villages in the infected neighbourhood with the view of early detection of Plague at new centres.

In Part III. I have put together 3 appendices viz.,

Appendix A. - Histories of Cases.

" B. - Daily Plague Returns.

" C. - A statement after Dr James, showing in a tabular form the names etc. of Villages in which plague appeared in 1897-98.

*J. P. Datta*

PART I.

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LIST OF AUTHORS AND MEDICAL JOURNALS  
REFERRED TO AND QUOTED.

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1. Quain's Dictionary of Medicine (Plague).
2. Dr Dhingra's pamphlet on Plague published at Lahore in 1898.
3. Dr Osler's "Principles and Practice of Medicine."
4. Indian Magazine and Review for 1895.
5. The Indian Lancets from 1897-1898.
6. The London Lancet.
7. Dr James' Report on Bubonic Plague in Bombay in 1896-97.
8. Ditto - in the Panjab in 1897-98.
9. Hakim Sharma's pamphlet on Plague, published at Hushiarpur in 1898.
10. Indian Medical Record for 16th April 1898.

## BUBONIC PLAGUE.

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### Synonyms.

This disease has been known by different names, at different places and at different times. The following is a list of its various names:-

According  
to Quain's  
Dictionary.

I. (1) The Pest; (2) Plague; (3) Bubonic Plague; (4) The Oriental Typhus; (5) The Septic Pestilence; (6) The Indian, or the Pali Plague; (7) Mahamari; - (vide the article on Plague in Quain's Dictionary of Medicine).

According to  
Dr Cantlie.

II. (8) Adynamic Typhoid Fever; (9) Intermittent Fever, with glandular swellings; (10) Haemorrhagic Fever; (11) Croupous Pneumonia with Buboes; (12) Typhus with glandular swellings, proving fatal by Pneumonia; (13) A peculiar form of Mumps; (14) Wan-Yik; Yang Tan Chang; Li-Ten-Cheng; etc., in China; - (vide Cantlie on Plague in Hong Kong, - Indian Lancet, dated 1st February, 1897).

Names given  
to Plague  
in India.

III. In the Panjab (North India) it is known by the name of (15) Phori, and (16) Táún. The last name has been taken from Muhammadan writers, who say the word is of Greek origin.

Some of the present day Hindu writers state that "Vidradhi" of the Vedas (Ayur Veda) is identical with Bubonic Plague; but Dr Dhingra of Lahore says that he has carefully studied the account of Vidradhi and found very little resemblance between it and Bubonic Plague; - (Dr Dhingra's pamphlet on Plague, 1898).



II. Definition.

Derivation  
of the word  
Plague.

In popular language, Plague means any epidemic disease attended with great mortality - disease and death coming as if it were by a sudden stroke or striking down. The word Plague in this sense has been derived from the Greek word  $\pi\lambda\acute{\eta}\gamma\eta$ , which means a stroke, from  $\pi\lambda\acute{\eta}\sigma\omega$  to strike.

It is in this general sense that the words ("Plague" and "Pestilence") are employed in Exodus ix, 14 and 15.

Hindu Defi-  
nition.

The Hindus define Plague as a "Localised inflammation of the fleshy parts of the limbs, as well as of certain other organs of the Body, mainly, 1. The root of the tongue; 2. the breasts; 3. the testicles; and 4. the root of the ear." (Vide Pamphlet on Plague by Hakim Gurudas Sharma of Hush-iarpur, published in 1898).

Muhammadian  
Definition.

Hakim Shaikh-ul-Rais defines plague as follows: "A disease producing great weakness in the limbs, great weakness of the heart, and which is attended with a localised inflammation of the skin, the colour of which undergoes certain changes."

Dr Osler's  
definition.

Dr Osler defines Plague as a "Specific, contagious disease, characterised by fever, inflammatory swellings of glands and haemorrhages."

Dr Cantlie's  
definition.

Dr Cantlie defines it as "an acute febrile disease of an intensely fatal nature, characterised by

inflammation of the lymphatic glands, marked vascular and cerebral disturbances, and by the presence of a Specific Bacillus."

Of these two definitions, the former is logical and therefore preferable.

In Dr Cantlie's definition, the following statements are redundant:-

1. "Of an intensely fatal nature."
2. "Marked by vascular and cerebral disturbances."

About the first statement we may allege that the "intensely fatal nature" of plague is a quality which is common to the whole of the next higher Genus "acute fever;" and is therefore not necessary to mark out class "Bubonic acute Fever" from other "acute Fevers."

His second statement - "marked by vascular and cerebral disturbances" is redundant, being included in, and implied by, the words "acute febrile disease." All acute febrile diseases produce marked vascular and cerebral disturbances. The proper place for describing their degree is under head "Symptoms." Furthermore Dr Cantlie's statement that Bubonic Plague is characterised "by the presence of a specific Bacillus" is fully covered by the word "specific." As to the nature of the special cause of the disease, a full description of it can be given under head "aetiology."

III. History  
of Plague  
Epidemics.

In tracing the History of Plague, we must keep in view the two-fold meaning of the word, viz.,

1. Its popular meaning; and
2. the medical meaning.

The former is applicable to any disease causing deaths in an epidemic form suddenly as if with a stroke. The latter is the name of a certain definite and specific disease, characterised by a definite chain of symptoms, which is termed here Bubonic Plague.

The Biblical  
References,

Book of  
Exodus.

I have referred above to the occurrence of the words "Plague and Pestilence" as found in the Book of Exodus. There they are used ambiguously for different diseases and afflictions which caused deaths among the Egyptians in large numbers in quick succession or even simultaneously.

Book of  
Deuteronomy.

In the book of Deuteronomy (ch. xxviii. verses 59-62) the word plague is employed in a like sense.

First Book  
of Samuel.

In the First Book of Samuel, however, (chapters 5 and 6), we have a reference to true Bubonic Plague; for "Emerods in the secret parts" and "the images of these emerods" and "the mice of gold" mean nothing less than an allusion to the "Buboes" and "rat murrain", so characteristic of the Bubonic Plague.

This takes us back to the years 1095-1115 B.C.

The Vedic  
(Hindu) Re-  
ferences.

"Recently", says Dr Dhingra of Lahore, "a



certain Hindu exponent of Vedic medicine, as given in the Ayur Veda, (one of the most sacred and ancient religious Books of the Hindus,) has stated that the disease therein described as Vidradhi was no other than true Bubonic Plague. But I have studied the passage carefully and have not discovered much resemblance between the two."

The first Professional Reference.

The first professional mention of Bubonic Plague is said to have been recorded by Oribasius, physician to Emperor Julian (A.D. 361-63). He quotes from Rufus (Alexander) who lived in A.D. 98-117, in the reign of Emperor Trajan, and states that Plague was then known in Lybia, Egypt, and Syria: and had been known there since the 3rd century B.C.

As known in Lybia, Egypt, and Syria.

Its first appearance in Europe.

Its first appearance in Europe is said to have been in the 6th century A.D., in the reign of Emperor Justinian, (527-565).

At this time it spread from Egypt into all the then known parts of the world: and remained established in Europe until 1809.

Black Death of 14th century.

In the 14th century, it came from the North of China, and was characterised with the occurrence of gangrinous inflammation of the respiratory organs, with fixed pain in the chest and vomiting of offensive blood. This gave it the name of Black Death.

Hirsh and others believe that "Mahamari,"



"Pali," or "the Indian Plague" of the 14th century were of the same nature as Black Death.

In 1348, Plague appeared in Bristol. Before this, it was never known to have appeared in England; and then remained here for 300 years,

It reached London in 1348, all the way from the Levant, from whence it had also spread to the Caspian coast, the Bosphorus and the Adriatic. It was epidemic in Cairo, Damascus, Byzantium; and they were the mile-stones of its onward journey.

Boccaccio limned it at Florence. Petrarch spoke of it as a world's wonder; and Laura died of it at Avignon. Archbishop Bradwardine of Canterbury died of it at Lambeth on 26th August, 1349.

In India, the year 1345 was the Plague year. Famine and Plague were both in evidence. (Indian Lancet, June 16th, 1898, page 612).

Delhi under the Tughlaks, at this time, suffered fearfully.

Its area began diminishing in the latter half of the 17th century. During 1661-81 Plague disappeared from Italy, England, Western Germany, Switzerland, Netherlands and Spain.

During the first half of the 17th century, Plague raged in India, round about Benares, when

Its area began diminishing in the latter half of 17th century.

Poet Tulsi Das of Hindu fame, probably died of this terrible disease. This was in Sambwat 1680 of Bikranajit, i.e., in 1623 A.D. It appears that Plague remained in India at this time, from 1616 to 1624 A.D. (Vide Indian Lancet, page 85, for July 16th, 1898).

Emperor Jehangir (says Mr Rogers in the Indian Magazine and Review for 1898) describes this epidemic as having devastated Delhi, many thousands having perished, probably 100,000.

Its history  
in the 18th  
century.

In 1703-13, there were serious outbreaks in Turkey, Russia, Austria, Hungary, Poland, Bohemia, and Eastern Germany.

In 1720-22, there was an outbreak in Provence.

Its history  
in 19th cen-  
tury.

By 1833, plague remained confined to Eastern Turkey; and in 1841, it ceased to be in Europe.

In 1843, it disappeared from Persia, Asia Minor, Mesopotamia, Syria and Palestine.

And by 1844 it disappeared even from Egypt. (Vide article on Plague Bubonic, in Quain's Dictionary of Medicine.)

As far as England was concerned, Plague ceased to exist there after the epidemic of 1665.

From France, it disappeared, after the great epidemic of 1720 at Marseilles.

The epidemic of 1770 at Moscow was a terrible one.

In 1815, it was prevalent in Kutch, Guzerat and Sindh, (India).

In 1828-29, it was in Hansi.

In 1836-38 it was prevalent at Barely, Pali, and Jodhpur.

In 1844, as stated above, it seemed as if plague after disappearing from Egypt (the home of Plague), had disappeared from the world; but as suspected both by Gavin and Milroy, it had not done so; for in 1853 it reappeared in the Levant.

1853 - In Yemen, etc., (Assyr country Western Arabia).

1855-59 In Bengazi; - (Tripoli, North Africa).

1863. In Maku; - (Persian Kurdistan, where it is endemic. (Vide Indian Lancet of 1st February, 1898).

1867. Along the Marsh Bank of the Euphrates, South and West of Hillah, and the position of Ancient Babylon.

1874-77. It spread from Baghdad to Suke - Sheyukh; and from the Tigris to the Syrian Desert. In 1874 it was again prevalent in Western Arabia (the Assyr country). Also in Bengazi (North Africa). In 1876 it was in



Northern and Eastern Persia; as well in Kamaun and Garhwal Districts in Northern India. Here, too, Plague is now endemic.

1877. It was prevalent in Resht (Ghilan Persia) as well as in Baku and Astrakhan.

1878-79. It was present in Persian Kurdistan, and at Vettionka on the Lower Volga.  
(Vide Quain's Dictionary).

1882. M. Rocher found plague endemic in Pakhoi (China).

1893. It broke out again in Assyr country in October 1893, with three more epidemics as follows:-

1. July 1894.
2. August 1895.
3. October 1896.

(Vide Indian Lancet for August 1st, 1898, page 122. With this statement, the "Times" of India does not agree for want of sufficient proof. According to this paper there have been no epidemics of Plague along the Persian Gulf, in the lower reaches of the Tigris and the Euphrates for more than 20 years, i.e., not since 1878).



1894. From Yunan Plague spread into Canton, Manning, Wuchow and thence into Hong Kong, causing great mortality at Canton.
1896. In Bombay Plague became epidemic in September 1896.
- From this centre it extended to widely separated parts of India as follows:-
- |                  |      |   |                     |
|------------------|------|---|---------------------|
| Poona,           | .    | . | 8th October, 1896.  |
| Karachee,        | .    | . | 10th December 1896. |
| 1897. Cutch,     | .    | . | 1st January, 1897.  |
| Hyderabad Sindh, | 12th | " | "                   |
| Sukhur,          | .    | . | 12th February "     |
| Rohri,           | .    | . | 23rd " "            |
| Hardwar,         | .    | . | March, "            |
| Khatkar Kalan,   |      |   | April, "            |
| Birampur,        | .    | . | 10th December "     |
1898. It is now present at the end of 1898 in the following countries:- China, India, Madagascar and in Samarkand.
- The cases of Plague which occurred in Vienna in October 1898 were traced to the Bacteriological Department of the Hospital there in connection with experimental work. The plague germ cultures there were from the bodies

of two imported Plague cases that had occurred in London at the Seamen's Hospital, Greenwich, in September and November, 1896.

The History of the Epidemic in 1897-98 in the Jullandhar District, (according to Dr James - vide his report on the Plague in the Panjab).

An account of the outbreak of Plague in the Jullandhar District (Panjab) in 1897-98.

Ram Saran returned from Hardwar to Khatkar Kalan on 28th April 1897, in an Ekka with high fever. He was delirious. He had been in that condition for several days at Rahon, a town 8 miles away from Khatkar Kalan. He soon became collapsed, semi-unconscious and died the next morning. He had no family. His property went to Hari Ram and Bhag. Eleven days after, his relations met in the room in which he had died to perform the eleventh day funeral ceremonies, (called "Kiria Karam.") There they remained for a few hours and then returned to their homes, locking up the room of the deceased. For two months after there was no illness in the village and no one died. Then in July Chandu, a washerman, died after one week's fever. He was an old man and had not left the village <sup>for some time</sup>. Next died a woman named Malan, a distant relation of Ram Saran, the first case. This was on August 9th after an

illness of one week with fever. She was aged 60 years; and had not left the village for a long while.

Her son Ralla, aged 30 years, became ill at about the same time, remained ill for a month and died on 13th September. He had enlarged glands in his groin, but it is stated he had previously suffered from syphilis.

While Ralla was still ill, one of Puran Chand's sons was attacked with severe fever. He was ill for ten days and died. His younger brother, aged 4 years, became ill later and died very soon after.

Banna Rawal returned from Poona in March - had phthisis - was bed-ridden and died in September. None of his relations suffered.

At the beginning of August the rats in the village were noticed to be dying out in the open. This seems to have been first noticed in Hari Ram's cattle shed near Malan's house.

In September some Jats, living near Malan's house got infected. Jhandu's daughter, aged 10 years, was ill for two days and died.

At this time some Chamars became ill also. Their houses joined some of the infected Jat houses.

Two deaths took place on October 9th,

1 on the 13th,



1 on the 14th,

4 on the 15th of the same month.

The villagers got frightened and reported at Bunga (the nearest Police Station) that some terrible form of fever was devastating the people. The Hospital Assistant of Bunga visited the village at once, and reported to the Civil Surgeon of Jul-landhar that there were many sick in this village. The latter examined these patients and pronounced the disease to be Bubonic Plague. On 21st October the Sanitary Commissioner of Panjab made his inspection of this village and officially announced the presence of Plague there.

It cannot be said positively that Ram Saran brought the infection from Hardwar, but it is probable that he did. The disease in the Panjab hot weather is mild and not very fatal. Cases have been observed in July at Garhi and Aur, which were so mild that they could easily have been overlooked, had they not been examined by duly qualified medical men. At Hardwar there was plague at the time when Ram Saran went there in April. The first cases occurred among his clan men and in houses adjoining his and their houses.

We may conclude that,

1. Plague can exist in a mild form in our



villages in the hot weather unsuspected; and

2. That it can break out in full virulence as soon as the colder months set in.

The History of the outbreak of Bubonic Plague in the Hushiarpur District.

The History of Bubonic Plague in the Hushiarpur District in 1897-98.

As stated above by Dr James, plague broke out at Khatkar Kalan in August 1897. This village is situated at a distance of about eight miles from the borders of Hushiarpur District. The people of Khatkar Kalan, I found during my village inspection tour, were greatly related in one way and another with the people of the Garhshankar Sub-division of our District, (Hushiarpur).

(1). The first imported case occurred at the village of Jandiala in the person of a Sikh woman, Uttam Devi. She was segregated, her house, etc., was burnt and there was no further extension of the disease. This was on 20th October, 1897.

(2). The second imported case was of a Sweeper woman, who left Khatkar Kalan on or about the 15th of October, 1897, and reached the village of Birampur either the same day, or the next day - a distance of sixteen miles. She died at Birampur on 19th October 1897.

After this date and up to December 11th, 1897,

the following deaths took place in this village -  
from causes stated to be other than Plague:-

On November	9th,	1897,	1	death.
"	"	15th,	"	1 "
"	"	18th,	"	1 "
"	"	24th,	"	1 "
" December	3rd,	"	1	"
"	"	4th,	"	1 "
"	"	8th,	"	2 deaths.
"	"	9th,	"	1 death.
"	"	10th,	"	4 deaths.

It was on this date that plague was suspected to have broken out in this village. On the next day I arrived there and examined all the cases shewn me then, when I found two genuine fresh cases with buboes developed in both.

(3).

To the village of Simal Mazara the poison of Plague was brought by a Faqir (or mendicant) family on 26th January 1898, from the village of Shikohpur. Albela, his son and his daughter Risi, went to Shikohpur on 25th idem to condole with the family of their relation Baz, on the latter's death from Plague. On the 26th they returned to Simal Mazara (a distance of about 10 - 12 miles from Shikohpur). The next morning Albela and his son left Simal Mazara for the village of Bachhwan. The latter

~~either on the road or~~  
 died that very evening soon after his arrival there.  
 His sister Risi remained at Simal Mazara. She died there on 7th February, i.e., on the 14th day of her return from Shikohpur. Her husband died the same day. On the 8th idem I examined this village and found the three remaining members of the family, all down with plague.

From these two centres (Birampur and Simal Mazara) 14 other villages were infected, namely,

1. From Birampur:-

- |                   |                  |
|-------------------|------------------|
| 1. Purkhowal      | 7. Hajipur.      |
| 2. Rampur Bilron. | 8. Garhshankar.  |
| 3. Bhajjal.       | 9. Garhi Jattan. |
| 4. Parowal.       | 10. Deron.       |
| 5. Sahdowal.      | 11. Bagwain.     |
| 6. Sanwali.       | 12. Palewal.     |

2. From Simal Mazara:-

- |             |             |
|-------------|-------------|
| 1. Kalewal. | 2. Chinkoa. |
|-------------|-------------|

The first case of Plague, as seen from the above account, was on 20th October, 1897. The last case was on 17th June, 1898. The total number of villages infected was 16.

The average duration of plague in each village after evacuation of village was 26 days, (vide Quotation from Dr James' report made further on

under head "Effect of evacuation of infected villages.")

The average duration of Plague in any village in the Hushiarpur District including the effects of evacuation was 36.44 days. (Vide paragraph 7, Sec. 2, Part II.)



IV. Geo-  
graphical  
Distribution  
of Bubonic  
Plague.

Hitherto Bubonic Plague was considered to have adhered to a certain definite area of the Globe, which Dr Cantlie describes as the "Plague Belt," and he states its boundaries and area as follows:-

Western Limit,	The Canary Islands.
Eastern       "	The Island of Formosa, off the Chinese Coast.
Southern     "	The Tropic of Cancer.
Northern     "	Indefinite. Sweden, Norway, and Moscow have been visited.

"In other words, Bubonic Plague," says Dr Cantlie, "has been met with from 19° West Longitude to 121° East Longitude; and between 40° North to 19° South Latitude." He also puts it concretely that the Mongoloid and the Indo-European races are all subject to it; and that no climate and no locality has any effect on it.

The Southern limits of the "Plague Belt" must now be altered; for according to Professor Koch and Dr Zulitza Plague is believed to be endemic in Uganda, which is situated on the Equator. (Vide. Professor Koch's address to the German Society for Public Hygiene on July 27th, 1898).

## V. Aetiology

Aetiology  
and the mode  
of spread.

The view  
held prior  
to 1894.

It had long been believed, from analogy with other Epidemic Diseases, that the cause of Bubonic Plague lay in some definite Pathogenic germ, but prior to 1894, all that was definitely known was that that unknown germ thrived best under certain associated circumstances, namely, filth, over-crowding, insufficient ventilation, drought and Famine.

The Hindu  
view.

The Hindus are great believers in the accuracy of the statement that the seasonal influences exercised on the surface of this globe are greatly modified by the conjunctions of various Heavenly Bodies in relation with it. They state that the Earth since 1895 is under exactly the same conjunctional relations with certain Heavenly Bodies as was the case thousands of years ago when great calamities (Drought, Famines, Wars, Plagues and Pestilences) visited this earth. The great war between the Kairao and Pandao Brothers, is stated to have occurred in Northern India (at Kuruchhetar) at that period.

The period of the present unhealthy, calamitous, and therefore unlucky conjunction has been calculated by Hindu rules of Astronomy to be 5 years; and so accordingly we may expect not to be done with the present visitation of Plague until the end of this

century. I am noting this statement of the Hindus as an instance of a coincidence, which if true, is a very remarkable one, strengthening as it does the idea held by many that the seasonal conditions of our earth are modified in some way by its ever varying position in the Heavens.

Be this theory of Heavenly influences as it may, there is no doubt that drought and famine prepare the way for the extension of plague into any given country. There is scarcity of proper foodstuffs, and people are compelled to live on inferior grains and other unwholesome articles of diet, with the result that their constitutions become weakened, and consequently less able to resist the pathogenic enemies, however introduced. Drought seems to bear no other relation in the sense of cause and effect to Bubonic Plague than the one mentioned above, <sup>that</sup> namely, it tends to prepare a suitable nidus in the systems of human creatures and other animals susceptible to Plague, owing to deficient production of foodstuffs.

As regards Famine, it may also act as a spreader of the Plague poison, for it is believed by some that rats infected with the poison of Plague may be carried from an infected area into a healthy one in the same way as healthy rats are conveyed. This is

Effect of  
Drought and  
Famine.



very possible, but we have not as yet been able to demonstrate this point by any absolutely proved statement of facts.

Famine, Rats,  
and Plague.

It has been stated that before Plague broke out in Calcutta last summer (1898), dead rats were found lying about in considerable numbers in the Press rooms of the East Indian Railway Company Station there, as well as in the Godowns connected with the coasting trade of Bombay. This has been considered by some as a sufficient proof that Plague was introduced into Calcutta from Bombay by these animals.

This may have been so; but there is no positive proof available in favour of this view to make it one of scientific value. Still the fact remains that at both these localities rat murrain <sup>is said to have</sup> preceded the epidemic of Plague among human beings; and that both these localities were connected with Bombay trade, where Plague had been raging already for two years. It is possible, then, that infected rats got into goods shipped at Bombay and were thus conveyed to Calcutta.

Extract from page 93 of Dr James' report.

Means of  
transference

1. Human.

There was plague in 86 separate villages. In 6 there was a recrudescence.



2. Clothes.

Of the 80 remaining villages, in 14 the source

3. Rats.

of infection was unknown.

In 67 it was traced to human agency. In 15 there was history of clothes or property having been conveyed from infected villages. In 5 infection seems to have been carried by rats. The following is the list of villages as related to each other in the matter of infecting each other:-

(1) Khatkar Kalan, infected

Birampur.

Jhanderkhurd.

Khankhanan, and

Shikohpur.

(2) Shikohpur infected

Mullupota.

Sahlon.

Ghutaron.

Kamam.

Simal Mazara, and

Bika.

(3) Birampur infected

Purkhowal.

Deron. (?)

Sahl Kalan, and

Gunachour. (?)

(4) Purkhowal infected.

Rampur Bilron.

Balon, and

Salh Kalan.

(5) Mallupota infected,

Mahlgahla,

Dhahan,

Bahrwal, and

Mazari.

(6) Mahlgahla infected.

Ladhana Jhikka,

Sodian,

Noura, and

Bhoura.

Extracts from Dr James' Report on Plague in the  
Panjab, 1897-98.

Rats as  
spreaders of  
infection.  
(Extract  
from Dr  
James' re-  
port on  
Plague in  
the Panjab  
in 1897-98.

Rats in connection with Plague. The medical officer in Bunga circle saw so many evidences where the only rational deduction to be drawn was that they had carried the disease from one house to another.

The variety of the rat found in these villages is the common brown rat (*Mus Decumanus*). They are shy, timid animals, which come out of their hiding places mostly at night or at times when no human

beings are about and when all is silent and still. They love dark, secluded places and usually live in large numbers where grain is stored; but they eat almost every kind of food even to offal; and under ordinary circumstances need very little water for their sustenance. They gnaw holes through wood, mud-walls, and other fairly hard materials and make free communication between adjoining houses.

It is a recognised fact that they have communications even with rats of neighbouring villages. (?) Through the Shipping Agency these rats have got introduced into Europe, where within the present century they have banished the indigenous rat of Europe, the black rat, (*Mus Rattus*). (Vide Sterndale's *Indian Mammalia*, page 323).

Another peculiarity of this brown variety is that if poison be put down in their vicinity and a few of them die by eating it, the rest of their community leave the locality in a body and the place becomes free of rats.

In Bombay it was found that inoculating a rat with Plague Bacilli almost invariably produced the disease, and the bacilli could afterwards be discovered in the blood, spleen, and other organs; and could be transmitted to other rats; that placing healthy rats in company with the diseased ones



caused them after a few days to take the illness; and that sometimes they died when fed on "infected food." An infected rat when seized with the plague fever comes out of its hole into the open and ceases to notice its surroundings. It wanders about in an aimless, tottering manner, and it looks as if "it were drunk or mad." It grows weaker and weaker and eventually falls on its side and dies, wherever it happens to fall. If it can get near water, it goes for it at once and drinks greedily as if it were suffering from unquenchable thirst. In its eagerness to drink it falls in and is drowned.

Rats at  
Mahlgahla.

Mahlgahla was evacuated on March 17th. Up to this only Sweepers and Chamars had been attacked, although infection had been brought here by a Jat girl. For eight days after the evacuation there were no more cases. At the end of March disinfection of Chamar quarters was commenced. More Chamars at once became infected from their homes. On 6th April a Jat visited his house which had been left uninhabited for 20 days. He was struck down. Each time a new street was commenced more cases occurred among the workmen. Numerous dead rats were found all over the village.

Rats and  
crops.

The wide increase of the disease corresponded with the appearance of the ear in the corn and its

decline with the filling and closing of the granaries. The increase began in February, was at its height in March and April and then it began to decline quickly. (Infected rats may have gone into fields and thence into different villages spreading the disease).

In February 10 new villages were discovered infected with plague. In March 23; in April 29; and only 7 in May, June and July.

In February the rainfall was heavy, but afterwards the weather was dry.

At the village of Mukandpur, Dr Wilkinson found nearly 200 dead rats in one infected house, and in another 15.

Many instances are recorded where rats died before the occupants of infected houses.

At Khatkar Kalan this rat murrain is said to have occurred in August 1897, the epidemic breaking out among human beings in October following. When Khatkar, however, was disinfected, not a single rat was found in the village - except in a non-infected part of the village - the Bharai quarters, which was found infested with these animals.

At the village of Khankhanan one of the first houses to be attacked with plague was of one Bhagwana. Adjoining his house at the back was one of

Rats at  
Mukandpur.

Rat Murrain  
before  
Plague broke  
out among  
human beings.

At Khatkar.

At Khank-  
hanan.

a certain carpenter named Bhagwan Singh. The occupants of these houses had nothing to do with each other. One day Bhagwan Singh and his family noticed a rat coming out of its hole in the wall. This hole went into the adjoining infected house. The family noticed that the rat took no notice of their presence and that it was more or less unconscious; and after wandering about for a short time it lay on its side and died.

The following day several members of this family were attacked with plague.

At Chak  
Kalal.

In the village of Chak Kalal, before any case had occurred among its human inhabitants, rats had begun to die in the characteristic manner peculiar to plague. The village was evacuated on the 7th of April. On the 15th the rain having threatened, the villagers returned to the village. There they found numerous dead rats in their houses. After staying there for 2 - 3 hours they returned to their camps. One of these rats which had just died was examined. Plague Bacilli were found in its blood and spleen, and gave characteristic growths on Agar. The same evening two persons in the camp were attacked, after which the epidemic became severe and there were altogether 32 attacks with 19 deaths. It is not known how the rats became infected, whether



by rats of some neighbouring villages, of which  
 whether  
 there were several within a mile, or through a cer-  
 tain man Sundar Singh, who had been to see a plague  
 patient at Sotran, on or about the 25th March. (He  
 however had been segregated and none of his family  
 had suffered. He himself remained well also).

At Punian.

In Punian rat murrain began 8 days before the  
 outbreak declared itself among human beings.

At Lalpur.

At Lalpur a "few days" before.

At Hamirowal

At Hamirowal rats began to die before the vil-  
 lage was evacuated. No cases occurred among the  
 human beings there.

At Lehl.

At Lehl also rats died before human beings  
 were infected.

The idea is that in these 6 villages infected  
 rats came from neighbouring villages - and all in  
 the month of April.

The period of incubation in the rat is 2 - 3  
 days after inoculation, and more when infection is  
 taken in other ways.

Dr Smith's  
 views on  
 rats - they  
 do not  
 spread  
 plague from  
 house to  
 house.

Dr Smith on the other hand states that he care-  
 fully went into this subject in connection with  
 plague in 22 villages in the Nawanshahr circle, and  
 found that rats lived in colonies; that in infected  
 houses they were all dead, and in non-infected  
 houses they were all alive. But he found no dead

rat in a roof in which live rats were found. He never found a live rat in a roof in which dead ones were found.

Dr Walton's  
view on rats  
as spreaders  
of Plague.

Dr Walton states that he was convinced that rats spread the infection from house to house; but that he never saw rats migrating from one village to another.

My own ex-  
perience on  
rats in con-  
nection with  
Plague.

My own experience in the matter is that at Birampur, Purkhowal, Rampur Biron, and Deron, I never saw a dead rat in any house; but that I did find live rats in infected houses at Birampur.

About Purkhowal, however, I was informed that dead rats were found in the house of Phillu. (Vide "account of plague in the Hushiarpur District" as given in Part II.)

The people of Parowal and Hajipur told me that among them rat murrain had preceded the epidemic outbreak among human beings.

Similarly at Bhajjal, my successor, Dr Heard found a colony of dead rats in the first infected <sup>there</sup> house, namely in the house of Mihun brothers.

Other ani-  
mals infec-  
ted by  
Plague.

As regards other animals being the agents of spreading plague, Dr Cantlie states as follows from his experience at Hong Kong. (Vide his article as published in the Indian Lancet, 1st and 16th February, 1897).

1. Pigeons.                    1. Pigeons were severely attacked in Bombay - not in Hong Kong.
2. Snakes.                    2. Snakes are said to be affected by Plague. (Vide Dr Thomson in the British Medical Journal for September 8th, 1895, page 560).  
  
The same has been observed at Kumaon. This is perhaps because snakes eat up rats.
3. Dogs.                    3. Dogs. Dr Mouchard (vide Chinese Customs Medical Gazette 47th and 48th issues) says that dogs have been seen to suffer from Plague in Yunan, owing to their eating corpses of plague patients.
4. Pigs.                    In Yunan pigs also were seen to become infected by eating human flesh of plague patients, (so says Dr Mouchard).  
  
[At Khad, near Poona, a severe plague epidemic broke out among pigs resulting in great mortality this year. (Vide The London Lancet dated 17th December, 1898, page 1667).]
5. Oxen, sheep and goats.                    Oxen, sheep and goats, says Dr Cantlie, are not known to be subject to Plague.
- My own experience in this matter. }                    In this connection my own experience is this:-  

(1) I have seen no fowls, dogs, snakes, pigeons, or in fact, any bird, suffer from plague in the Hushiapur District. Nor was any plague seen among sheep and goats. In all the infected villages there were herds of sheep and goats and
1. Fowls, Dogs, Snakes, Pigeons, Sheep, Goats.



there was no death traced to plague among them. The people of Purkhowal and Hajipur had their sheep yards in their houses; and although the epidemic of Plague among human beings in them was severe, no sheep or goat suffered.

Dogs.

Again as regards dogs, they are found in numbers in all Indian villages as Pariah or ownerless dogs. They roam about from house to house and live wherever they find it convenient to do so. This continued to be the case during the epidemic in all the infected villages in the Hushiarpur District with no harm accruing to them. Indeed at the Birampur Plague Hospital and segregation camp the village dogs were frequent visitors and I watched the same dogs continuing to live there the whole time the people were there, and yet no dog died from plague.

Oxen and  
Buffalo.

As regards cattle (oxen and buffaloes), there were only three suspicious deaths, 1 at Birampur, and 2 at Purkhowal. My conviction is that they died from plague; but I cannot say so positively, for I made no microscopic or culture examination. The one at Birampur was an ox which strayed into the village one night after it had been evacuated. It was found dead, next morning in its owner's empty house. No bubo could be made out.

The other two heads of cattle which died most probably from plague, belonged to the segregation camp of Purkhowal. They were a buffalo and its young calf. Both were well in the evening one day; next morning they were found dead. The calf had a bubo-like swelling under its lower jaw.

I must note here again that in almost all the infected houses there were cattle of all sorts, cows, oxen and buffaloes; and yet the above were the only three instances of death among them. The reason perhaps why so few of them suffered from plague was the fact that they were mostly tethered in the open at night outside the houses, and were let out grazing in the woods, etc., during the day.

(2)  
Horse.

(2) The only horse that died and most probably of plague, belonged to the native doctor of Birampur. The death was sudden, there was infection in the house and the doctor rode her daily while out doing plague treatment according to the native system of medicine. No microscopic examination of the blood etc., was made in this case either, owing to local difficulties.

(3)  
Cats.

(3) I saw no cat die of plague in the Hushiar-pur District.

Monkeys.

[ In the town of Hardwar, monkeys suffered from plague in the epidemic of 1897-98. (Civil and Military Gazette, 1897). ]

INFECTED FOOD.

GRAINS.

---

Food Grains  
and Plague.

As to infected food grains themselves being the medium of plague communication, it is possible, but not very probable.

Mr Hankin's  
experiments.

In this connection I may note here the results of careful experiments made by Mr Hankin under the orders of the Indian Government. They are as follows and have been taken from his report dated 17th February, 1897, to the address of the Secretary to the Bombay Government.

(1) In the first set of experiments he employed cultures of Plague Bacilli obtained

(a) from a human plague corpse, and

(b) from a rat which had died of plague.

These cultures were used on the 7th day of their growth. The contagion thus prepared was mixed with the grains to be experimented upon; and from these infected grain solutions, injections were made into healthy rats with the following results:-



No. Serial.	Name of grain in solution.	Immediate injection.	Injection after keeping the solution for 2 days.	Injection after 4 days.	Injection after 11 days.	Injection after 13 days.	Remarks.
1	Linseed.	The rat died in 24 hours.	The rat died in 7 days.	The rat died in 13 days.	Survived.	Survived.	
2	Yellow Rape seed.	72 "	24 hours.	Survived.	Do.	*Died in 24 hours.	*This death was from some other cause, but not plague. No
3	Brown "	24 "	4 days.	Do.	Died in 24 hours.	Survived.	plague Bacilli found in the body.
4	Til seed.	48 "	Survived.	Do.	7 days.	Do.	
5	Ground Nuts.	24 "	Died in 11 days.	Do.	24 hours.	Do.	
6	Castor seed.	Do.	48 hours.	No further experiments with this solution.			
7	Poppy seeds.	Do.	Do.	Survived.	Survived.	Survived.	
8	Wheat - new red.	48 hours.	Survived.	Do.	Do.	Do.	
9	Wheat - another kind.	Survived.	Do.	Do.	Do.	Do.	
10	Flour.	Died in 24 hours.	Do.	Do.	Do.	Do.	

(2). In the grain called Bajri the plague Bacillus dies in 2 days.

(3). In this set of experiments the contagion was taken from the Liver and Spleen of a plague smitten rat, and the results were as follows:-

No. Serial.	Name of grain in solution.	Immediate injection.	Injection. after keeping the solution for 2 days.	Injection after 4 days.	Injection after 6 days.	Remarks.
1	Linseed	The rat died in 48 hours.	The rat died in 24 hours.	*The rat died in 5 days.	Survived.	*Died not of plague.
2	Yellow Rape-seed.	<sup>†</sup> Survived.	Survived.	2 days.	Do.	<sup>†</sup> Dose weak, fewer microbes.
3	Brown "	Died in 5 days.	Do.	2 "	Do.	
4	Til seed.	6 days.	Do.	Survived.	Do.	
5	Ground nuts.	6 "	Died in 24 hrs.	Do.	Do.	
6	Poppy Seeds.	<sup>†</sup> Survived.	" 3 days.	Do.	Do.	
7	Wheat, 2nd quality.	Died in 4 days.	Survived.	Do.	Do.	
8	Flour.	Do.	Do.	Do.	Do.	

(4). In the fourth set of experiments, the contagium was the sputum of plague patients. Surgeon Captain Childe has shown that the sputum of plague patients is full of Plague Bacilli.

No. serial.	Name of Grain in solution.	Immediate injection.	Injection after keeping the solution for 2 days.	Injection after 4 days.	Injection after 6 days.	Remarks.
1	Yellow Rape-seed.	The rat died in 24 hours.	The rat died in 24 hours.	Survived.	Survived.	
2	Brown "	Do.	Do.	Died in 24 hours.	Do.	
3	Till seed.	Do.	Do.	Survived.	Do.	
4	Ground Nuts.	Do.	Do.	Do.	Do.	
5	Poppy seeds.	Do.	Do.	Do.	Do.	
6	Wheat 2nd quality.	Died in 48 hours.	Died in 48 hours.	Died in 48 hours.	Do.	
7	Flour.	24 hours.	Do.	Do.	*Died in 3 days.	*This death was not due to plague, but to something else.



In all the above four sets of experiments the different grains were kept in cloth bags in a damp place, so that even mildew grew on them. This was done in order to simulate as much as possible the conditions under which grain is usually stored in Indian Godowns.

These experiments show that the poison of plague may survive up to the 13th day; but that it usually dies out within four to six days.

Mr Hankin has further stated that he has examined grains of several kinds, new, clean, and dirty, taken even from very suspicious localities; but that he did not discover the presence in them of the Plague Bacillus.

He has also examined weevils and other insects, parasitic on grains, but failed to discover the plague microbes in them.

I have given these experiments of Mr Hankin's to show that under ordinary circumstances food grains brought in Famine times even from infected localities, are not likely to be infected, and even when infected they are not capable of retaining the poison for long. It is clear from this that Famine per se is no cause of Bubonic Plague. Plague can rage where there is plenty with as much virulence as in a locality

Weevils,  
etc., and  
Plague.

Famine per  
se is no  
cause of  
Plague

where there is actual scarcity; and both conditions can co-exist side by side (plenty and famine) and yet there be no plague in either.

The same has to be said of filthiness of a place. In the same village, under exactly the same kind of insanitary conditions, plague may rage in one part, and there be no trace of it in the other. This was seen to be the case at the village of Purkhowal in the Hushiarpur District. Its western half called Tejpur escaped completely. The same was seen in every village which was visited by plague in the Hushiarpur District in 1897-98.

The two circumstances which are absolutely necessary for the production of Bubonic Plague are

- I. The contagion of the Disease, and
- II. Insufficient ventilation.

In the open air the contagion becomes attenuated and dies out. In badly ventilated houses and in over-crowded houses (over-crowding being practically the same thing as defective ventilation) the germs of plague thrive and become extremely virulent.

In 1894, almost simultaneously, but quite independently of each other, Kitasato and Yersin discovered that the cause of plague was a short

Filth per  
se is no  
cause of  
Plague.

The absolute  
and invari-  
able cause  
of Plague.

The Bacillus  
of Plague.  
Its Dis-  
covery.

Bacillus. They demonstrated its presence in the buboes, blood and the spleen, etc., of infected persons, and showed that it fulfilled Koch's "Three Canons" as to its being the specific cause of plague.

1. It is found in all plague cases and in no other disease.

2. It can, after removal from an infected body, be cultivated outside the animal organism, on various culture media, such as Agar, Bouillon, Potatoes, etc.

3. From these cultures when it is inoculated into the body of any susceptible organism, it produces the same disease, proved by the presence of the same Bacillus.

Dr Ogata of Japan, thinks that the Bacillus of Kitasato is different from that described by Versin; and that the latter is the true Bacillus Plagae.

This view has not been supported by anybody else. At Bombay, Versin himself has worked in connection with his anti-plague serum; and in none of his statements did he ever make a reference to this subject, whereas constantly the Bacillus of Plague was stated in his presence to be the one discovered by him simultaneously with Kitasato.

Dr Ogata's  
view on the  
Plague  
Bacillus of  
Kitasato.



Dr Aoyama's  
view on the  
Plague  
Bacillus.

Dr Aoyama, (another Japanese authority), states that the Bacilli found in the blood of plague patients are different from those found in the Buboos, inasmuch as the latter stain by Gram's method, but not the former.

I do not agree with this statement, although personally I have not tried Gram's method in staining blood films, but I can say this much, however, that by Gram's method plague Bacilli in Bubo sections do not stain. I have carefully tried it and not succeeded.

Dr Crook-  
shank's  
views on the  
Bacillus of  
Plague and  
the Bacillus  
of Fowl  
Cholera.

Dr Crookshank speaks on this subject as follows:-

"There is no doubt that the micro-organism which was found in the blood is very similar to the Bacillus of Fowl Cholera, and it is quite possible that the so-called Plague Bacillus is really identical with the Bacillus of Haemorrhagic Septicaemia; and that the real nature of the contagium in Bubonic Plague is yet unknown."

(Vide Dr Mohendralal Sircar's paper in the Indian Lancet, page 540, for 1st June 1898.)

With this view of Dr Crookshank's, we cannot agree in the face of our experience at Birampur, etc., in the Hushiarpur District. Here the Sweepers suffered from plague severely, and

yet their fowls remained perfectly well, although the latter were in and out in the same rooms where plague patients lay. Nay in many cases, the fowls were cooped up, in the same room at night.

There is really now no doubt that the Bacillus of Plague described by Kitasato, is the same as the one discovered by Yersin, - and that this identity of the Bacillus has been verified by M. Haffkine, Mr Hankin, and the members of the various scientific missions sent to Bombay by the Governments of Germany, Austria, Russia, Egypt, and several other foreign Scientific Authorities. (Vide, the speech of the Honourable Mr Risley, member of the Viceroy's Council in India, as quoted in Dr Sircar's article on Plague in Calcutta 1898, - Indian Lancet, 1st June 1898.)

These Bacilli are found in the buboes, the Spleen, and in some cases also in the general circulation. They have also been found in the lungs and other internal organs.

In the Bombay epidemic, Bacilli are stated not to have been found in the blood and excreta. Such was not however the case in Hong Kong in 1894, (Vide Dr Dhingra as quoted above.)

The parts of the body in which Plague Bacilli are found in a plague case. In Buboes, viscera and blood, & excreta &c:-

In the soil  
of infected  
houses.

They are found in the soil of floors of rooms in which plague cases have occurred. This has been verified in Hyderabad under Surgeon Colonel Lawrie's investigations. (Vide, Indian Medical Record, page 321, for April 16th 1898, Lawrie and Steven's experiments on the soil in plague infected houses.)

They state that these germs were found down to the depth of two inches from the surface of the floors, but not on the walls and roofs of infected houses.

Plague  
Bacilli not  
in wells  
and tanks.

I am of opinion that Plague Bacilli are not found in water of wells and tanks. I have made no experiments in connection with this subject, but I have observed that people drinking water from the same wells as used by infected communities, did not contract plague.

With cholera, however, the case is just the reverse. In that disease wells and tanks in India become infected and prove to be the centres of cholera distribution, the communities affected being those which use the same well.

The General  
characteris-  
tics of the  
Bacillus of  
Plague.

(1) It belongs to the aerobic variety of Bacilli.

(2) It is non-motile.\*

(3) It has not been known to spore.

\* Since writing the above, I have read Dr. M. H. Gordon's "note on Flagella of *M. mallei* & *Bacillus Pestis*" in the *Lancet* (London) of March 11<sup>th</sup>, 1899, page 688. It states that the Bacillus of Plague is motile & that it is provided with a *terminal* flagellum, as a rule only one, but that sometimes there may be 2, & rarely 3.



## Morphology.

The Bacillus of Plague is a short straight rod with slightly rounded ends. Each rod measures about  $\frac{1}{25,000}$  th of an inch in length and  $\frac{1}{10,000}$  th of an inch in width.

- (1) some call them Diplococci;
  - (2) some describe them as diplococci enclosed in one common capsule;
- and (3) some consider them to be short Bacilli with rounded ends with a clear space or band in the centre.

That they are Bacilli and not Diplococci can easily be seen by over-staining them, when even the intermediate space becomes as deeply stained as the ends.

Most of my preparations made at Birampur were so over-stained and showed the Bacilli of Plague appearing as short straight rods with rounded ends. The staining by now (after a year) has become, in some of them, somewhat faded, and the Bacilli appear boat-shaped, with ends deeply stained, with a clear central band. There is no separate capsule, (Vide microphotographs of Birampur Preparations in Part II. of this Thesis - pages 56-1 to 56-5).

Professor  
Woodhead on  
the Plague  
Bacillus -  
some after-  
death forms.

Professor Woodhead writes that "in a watery Gentian Violet solution, this Bacillus appears small; but that in a Glycerine Fuchsin solution, it appears larger." He also states "that in post-mortem preparations certain new forms of the Bacillus appear, which seem to be after-death developments." This last observation is important as it may give direction to the fuller study of this pathogenic microbe.

Staining.

The Plague Bacilli stain easily with Basic anyline dyes.

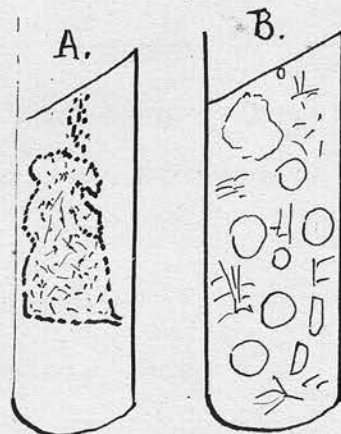
They do not stain with Gram's Method, at least I have not succeeded in staining them by that method.

Growth on  
Culture -  
media  
Temperature  
favourable  
& Time of  
appearance  
of growth.

It grows on ordinary Agar luxuriantly at 80° F. In twenty-four hours at this temperature a growth is first seen in the form of translucent whitish streaks and dots. In forty-eight hours it is more pronounced and has now an appearance of a web studded over with dots.

Appearance  
of growth  
on Agar-Agar.

In the margin are re-presented two rough sketches A. & B. showing what a growth of Plague Bacillus looks like when fully developed on sloped Agar-Agar. This is as was seen



at Birampur in the Hushiarpur District in December 1897. The gland from which the contagium was taken was carefully dissected under antiseptic precautions, corrosive sublimate solution (1 in 1000) being employed. This gland was found buried in a mass of bloody effusion. It had not yet suppurated, but was considerably enlarged and congested. The cut surface was swabbed with mercury lotion and then a loop full of its juice taken and inoculated into the surface of the Agar. The growth shown in Tube A. appeared as such on the seventh day. In B. the same is represented as seen under a hand magnifier.

Distinction  
between  
Streptococci  
Colonies and  
B. Communis  
Coli Col-  
onies.

The Colonies of Plague Bacillus on Agar are less transparent than those of streptococcus and their growth also is less rapid.

The Bacillus Coli Communis Colonies are more opaque and quicker in growth.

The Plague Bacillus growth does not extend into the Agar and does not liquify it.

If to the Agar be added 2 - 4 per cent of sodium chloride, the Bacilli grown on it are larger and more swollen. With three per cent of sodium chloride the Bacilli are swollen.

Growth on  
blood serum.

On blood serum at the body temperature the Bacilli thrive luxuriantly (Kitasato). They are



then moist and of yellowish grey colour. They do not liquify the serum.

Growth on  
Gelatine.

On Gelatine, they form light brown finely granular colonies. The gelatine is not liquified.

Growth in  
Alkaline  
Bouillon.

In Alkaline Bouillon, a light scum forms under the surface; and when the test tube, in which this growth is progressing, is kept somewhat slanting, small flocculent masses form, which lie on the lower side of the test tube. If this tube be agitated they fall to the bottom and disappear, leaving the fluid quite clear. (Hankin)

The addition of a little grape sugar increases the growth. (Kitasato)

Professor Haffkine adds to the Bouillon a drop of clarified butter called Ghi in India. After several days a white scum forms on the surface, and from it are seen hanging down thread-like prolongations, like the roots of duckweed in a pond, or like stalactites. On slightest movement these threads, or chains of colonies, break and fall to the bottom of the flask.

Growth on  
Potatoes,  
etc.

On Potatoes and Plantains the growth is scanty. (Vide Dr James' Report on Plague in Bombay, 1896 - 97.)

Bacillus of  
Pestis Minor

Dr Cantlie thinks that the Bacilli of Pestis Major and Minor are similar, differing only in

their toxic power. He states, that they may both run their course separately and independently of each other; but that the Benign form may pass into the Malignant, possibly after passing through some host.

{This statement is only hypothetical and requires further research, which may either confirm or disprove it. At present the question is an unsettled one. Dr Cunningham of Calcutta in 1896 declared that the Bacillus described by Dr Simpson, the then health officer of Calcutta, as being identical with the Bacillus of Kitasato, was not so in his (Cunningham's) judgment.

Drs Cantlie and Weir think the two Bacilli to be, if not one and the same, very similar. (Vide Indian Lancet, page 574, for June 1898.) Also see Dr Cantlie's paper in the same Journal for 1st February 1897.}

VI. Anatomical Characters.

As stated in Quain's Dictionary of Medicine.

1. As reported in Quain's Dictionary.
  - i. Ecchymosis of the coverings of the Nerve centres, Pericardium, Omentum and Peritoneum.
  - ii. Enlargement and softening of the spleen.
  - iii. Punctated extravasations in the Mucous Membrane of the stomach and intestines.
  - iv. Reddish black pigmentation of the mesenteric glands.
  - v. Extravasations of blood in the perinephritic cellular tissues.
  - vi. The kidneys may be tumified with extravasation of blood into their substance as well as in their pelves.
  - vii. The glands which become buboes are enlarged and have extravasated blood in their substance.

The lymphatic glands in the great cavities of the body may be inflamed in the same way as the buboes externally. Sometimes all the lymphatic glands of a particular chain are inflamed alike, such as the Bronchial, Mediastinal, Mesenteric or the Lumbar, etc.

2. As found in Bombay, in 1896-97.

2. Dr James states in his report to the Panjab Government, dated June 1897, that the following were the anatomical characters of plague as observed by the different Plague Medical Officers during 1896-97 in Bombay and Karachee.



Changes peculiar to acute fever.

The post-mortem changes are the same as in other acute fevers, except the changes which are found to exist in the Lymphatic glands and the greater preponderance of Haemorrhages in plague.

The Blood.

The blood is dark in colour and very fluid in consistence.

Petechial Discolourations.

The skin is very apt to show petechial discolourations. These are also present on the Visceral layer of the pleura, pericardium and the peritoneum. They occur also, on the Mucous surfaces of the stomach and the intestines.

Bubo.

The infected glands are enlarged and contain Haemorrhages in their substance. In some instances they appear like dark, soft masses of blood and broken down gland tissue.

Round the inflamed gland there is first a zone of variable size composed of extravasated blood. Outside this again there is found an area of oedema of the surrounding tissues.

These glands have a tendency to break down and suppurate. This often begins with the formation of a sero-purulent centre in the substance of the gland.

The extravasation round the bubo may extend deeply in among the muscles, etc., of the part affected and they may all be involved in the suppurative process.

In the acute stage, the bubonic glands are found gorged with Plague Bacilli, even when there may be very few or none in the blood.

#### Internal organs.

All the internal organs are enlarged and gorged with venous blood.

#### The Brain.

The subarachnoid and the Ventricles of the brain may be filled with serous fluid. Plague Bacilli have been found in this situation.

#### The Lungs.

The Lungs almost always show static congestion with oedema at their bases. Petechiae are found between the lobes and near the root of the Bronchi. Patches of Pneumonia and Haemorrhages may also be found in the lungs. Lobar Pneumonia is common: and sometimes there are seen patches of greyish necrotic lung tissue. These are found full of plague Bacilli.

#### The Heart.

The heart is little changed, except that it seems less firm than it is normally. The right side is found dilated and full of dark fluid blood. The left side is often empty and contracted.  
(Lawson.)

#### The Liver.

The Liver is usually enlarged, friable and of a dark chocolate colour. Its cut surface exudes a large quantity of venous blood. Petechiae are often found on its surface.

#### The Gall Bladder.

The Gall bladder is distended with bile.

Necrotic patches are sometimes found also in the Liver.

The Spleen.

The Spleen is much enlarged, congested and very friable. Large quantities of Plague Bacilli are found in this organ.

The Kidneys.

The Kidneys are congested; but their capsule is not adherent. Petechiae, seen as pinhole extravasations, are found on the Mucous surfaces of the calices. Sometimes the kidneys are found buried in a mass of blood (haemorrhage in the retro-peritoneal region.)

The Bladder.

The urinary bladder is either empty or partially distended with urine. In many cases the urine contains albumin.

3. Personal observation.

3. Personally I have had no opportunity of making a proper post-mortem examination, beyond looking at the eyes, the tongue, the bubo, etc. The result of this kind of superficial post and anti-mortem examinations may be stated as follows:-

(1) In Fulminant cases.

(1) In cases in which the disease was so virulent that death took place within a few hours from the onset of initial symptoms, i.e., in the Fulminant Variety - the external appearances mostly showed nothing characteristic either of plague or of any other disease. The bodies looked just as in health. In some, the eyes looked injected, the



pupils dilated but equal and the tongue white and coated. In one I found froth at the nares, and in one a bloody discharge from the urethra. Plague Bacilli were present in both the Mucous and the bloody discharge. In one there were purple red discolourations of the skin on inner surface of thighs and legs.

(ii) In other cases.

(ii) The bodies of patients, who have struggled against the attack for some time before succumbing to it, show signs of exhaustion, the degree of which varies with the stage of the fever at which death takes place. The face, neck, and the upper part of the trunk look cyanosed, the eyes injected, the pupils dilated and the tongue white, brown or black and shrivelled up.

The Bubo.

In a large majority of cases the Bubo is present and may be looked for. It may be in the groin, axilla or the neck just below and behind the ear. Very seldom in any other situation. As a rule there is only one bubo, sometimes two, less often three, but rarely more. Round the bubo is found a diffused swelling, which is due to serous and bloody extravasations <sup>taken</sup> having place in the tissues around. The gland or glands which form the bubo, are enlarged, congested or even converted into a mass of blood and broken down gland tissue,

the whole being held in the capsule as if in a thin sac. If the patient survive the plague fever proper, i.e., the fever of the 1st six days of the disease, the bubo may either gradually be absorbed by resolution; or it may take on a suppurative process. In the latter the surrounding oedema and extravasation area may be included and a large abscess be the result. Sometimes the whole bubo may slough away, leaving a large deep ulcer, which is very slow of healing.

#### Pyæmic Abscesses.

Sometimes the pus is carried from the bubo into the adjoining lymphatic glands, which also become inflamed and suppurate. Sometimes the pus is absorbed into the general system and either pyæmia or septicaemia may be the result.

#### Sudden disappearance of Bubo.

Sometimes the bubo suddenly disappears during the plague fever period proper, i.e., before the suppuration period. This probably means that the inflamed gland, owing to the thinness of its capsule and internal pressure from increased hæmorrhage into its cavity ruptures. Its contents thus become dispersed among the surrounding tissues and hence the sudden disappearance of the bubonic swelling and the attendant pain. I saw this happen in three cases of superficial buboes at Birampur, as well as in one case in which the bubo

was intrathoracic. In each case the after effects, as will be stated under head symptoms, were disastrous.

Bacilli  
fewer after  
suppuration  
in the Bubo.

The inflamed glands are full of plague Bacilli. After suppuration has set in, in the buboes, the plague Bacilli either disappear altogether or are reduced greatly in number. I believe they disappear, for I never was able to detect them in the pus of any bubo.

The Lungs.

In the pneumonic cases, the lungs became differently affected - pneumonia being limited to small patches scattered here and there, or extending over a whole lobe or whole lung, on one or both sides. The blood is very thin and haemoptysis in very large quantities takes place in severe cases of primary plague Pneumonia. It, the expectorated blood, is full of Plague Bacilli, so full that it seems like a pure culture of the Plague Bacillus.

Summary of  
Pathological  
Changes.

In conclusion we may say that the chief features of this disease are: -

1. Congestions, petechiae and haemorrhages in various parts and organs throughout the body.
2. Inflammation of one or more Lymphatic glands in any part of the body, but as a rule in one or other of those situated in the following superficial localities: -



Femoral, Inguinal, Axillary, or Post and  
Infra Auricular cervical.

And 3. The presence of the Plague Bacillus in large quantities in the bubo and in pneumonic cases in the lungs and always in the spleen. In very severe cases these Bacilli are said to be free in the general circulation.

VII. The Incubation Period.

Quain.

The results of the French Commission according to L. Arnauld, show the mean period to be five to six days, and the maximum period eight days.

Hirsh states the minimum period to be two to three days, and maximum eight days, and the mean period five days.

The Venice Commission of 1897.

The Venice Commission of 1897, puts down mean period at five days and maximum at eight days.

Dr James on the Bombay Plague, of 1896-97.

Dr James reports from his experience in Bombay and Karachee during 1896-97, that the incubation period of plague there ranged between two and eight days.

Dr Cantlie.

Dr Cantlie after Lawson gives this period as three to six days, and after Dr Aoyama as two to seven days.

He, (Dr Cantlie) adds however, that the incubation period of the Ambulatory Plague or Pestis Minor is very uncertain. In support of this statement he adduces the following instances.

(a) A Portuguese steward was admitted into the Seaman's Hospital at Greenwich on 15th September 1896, where after an illness of forty-eight hours, he died. This man had just come

from Bombay, and supposing that he took the infection on the day he left that port, his symptoms developed about eighteen days after.

(b) The second case was also of a sailor from Bombay. He had been for fourteen days on shore in England before he was admitted into the Greenwich Hospital. And supposing that he had taken seventeen days on the voyage, it took the poison thirty-one days before it declared its symptoms, which was on 31st October 1896. (Vide British Medical Journal, dated 12th December 1896)

(c) The third case quoted by Dr Cantlie in support of his statement, is that of the boy who died in Calcutta in September 1896. Dr Simpson declared that case to be one of plague. This boy was seventeen years old. He became ill with plague on 24th September 1896, fifteen days after leaving Bombay. During this period, the boy had noticed swellings of his glands in the groin, sometimes on the one side and sometimes on the other; but he was never actually ill enough to have to take to his bed. A diplococcus, like that of Kitasato's was found in his blood. The clinical symptoms developed in him were exactly like those of Bubonic Plague.

Dr Cantlie also alludes to the statement



that Pestis Minor had been in Bombay for some two months or over, before it broke out in the virulent form in September 1896, when Dr Veigas reported the first authenticated cases of true Plague.

Dr Cantlie also thinks that the cases of a peculiar fever, with glandular swellings, treated by him in 1891-93, at Hong Kong, were probably cases of Pestis Minor.

In 1891 he treated twenty-one cases of "a contagious idiopathic inflammation of one gland, situated at the middle of the sternomastoid muscle." They were attended with fever.

Prior to 1893, he treated thirty-three cases in the course of thirty-two months. In these the buboes were non-veneral, Inguinal in position, of slow growth and attended with anaemia and fever. They suppurated at the twenty-first day. Round them was found periglandular serous effusion.

In 1893 he noticed cases of fever, then called "Typho-Malarial," which were attended with the formation of a bubo in the fourth week.

Dr Viegas of Bombay, gives the history of a case which throws very definite light on the

Dr Viegas  
on the in-  
cubation  
period.

incubation period of the true Bubonic Plague.

A Hindu lady, named Laximibai, reached Bombay from Mahabaleshwar on 12th November 1896. On the 17th idem at 2 a.m., symptoms of plague fever set in. This gives five days for the incubatory period in her case. (Vide Indian Lancet, for 16th March 1897.)

Dr James  
after Pan-  
jab ex-  
perience.

Dr James states in his report on Plague in Jullandhar (Panjab) 1897-98, as follows:-

The incubation period of plague is probably between two and eleven days, and the best example to quote is that of the village of Chak Kalal.

Here, up to the 15th of April, there had been no cases for ten days, among the villagers, who had left the village owing to deaths among rats, having been seen in their houses. On the 15th they went to the village for two hours and finding more dead rats returned to camp again. It was now that they became infected and seizures among them occurred as follows:-

After	1 day	none
"	2 days	3
"	3 "	7
"	4 "	7
"	5 "	1
"	6 "	2
"	7 "	2
"	8 "	2
"	9 "	3
"	10 "	2
"	11 "	2

He also states that nearly all the cases of attacks took place within the first eleven days after evacuation of villages. When they were attacked at a later period, there was nearly always suspicion or actual proof that they had obtained their infection at a later date.

Among the workmen employed on disinfection work, this period varied between two and five days.

From my own experience I can quote ~~four~~ cases which seem quite clear.

1. Kanhaya of Birampur was attacked with plague on the night of the 19th December 1897. The most likely mode of his being infected was through the clothes of his son, Faqiria, who had been doing water carrying duty at the Birampur Plague Hospital since the 13th of the same month. This makes six days at the outside.

11. The shortest period noticed at Birampur was six to eight hours. On the 24th, Jan. 1898, Rahmat Khan was allowed from his camp to go and close up the roof of his house, as heavy rain was threatening. This he did between 10 a.m. and 6 p.m.. At the end of it he returned to the camp and began feeling ill, and died on the 31st idem.

Personal  
experience  
{Hushiarpur}  
District. }



111. Under similar circumstances, Roshan Ali became infected, and developed symptoms in eleven to nineteen hours, and died a few hours afterwards.

1V. Infected in the same way as the above two cases, Niamat Khan was attacked two and a half days after receiving the infection. He recovered.

VIII. The  
Sporadic  
Period.

By this we mean that period of the Epidemic during which the cases of plague occurring in a community into which the poison has been introduced, are far and apart, are mild, and as a rule non-fatal. It is this form of plague to which the name Pestis Minor has been given.

(1) In the London Plague of 1665-68.

(1) In the London Plague of 1665-68, this period was about six months long. The first case of plague here, occurred at the end of November or beginning of December 1664. Plague became epidemic in the month of June following.

(2) At Marseilles in 1720.

(2) At Marseilles in 1720 the infection of plague was imported from Syria on May 20th. By the end of June, plague was scattered all over the town, i.e., within forty days after the introduction of the infection.

(3) At Moscow in 1770.

(3) In Moscow the first cases occurred in either October or November 1770. The disease became epidemic in the spring following.

(4) At Bombay, in 1896.

(4) Into Bombay infection probably found its way in May 1896. It became epidemic by the end of September following.

(5) At Calcutta in 1898.

(5) In Calcutta the first authentic case occurred early in the summer of 1898, and in three months' time it was all over the town.

(Indian Lancet, dated September 17th 1898, page 739)

(6) At  
Karachee  
in 1896-97.

(6) In Karachee the first case occurred on 10th December 1896, and the last on July 27th 1897. (1st Epidemic.) Here the Sporadic period was about one month. (Indian Lancet, September 24th 1898, page 821.)

(7) At Khatkar Kalan,  
Panjab, in  
1897.

(7) At Khatkar Kalan (Panjab) the first case probably occurred on 28th April 1897, in the person of Ram Saran, who brought the infection from Hardwar. The disease became epidemic in the middle of September following. Namely, after four and a half months.

(8) At Birampur, Panjab,  
in 1897.

(8) At Birampur (Panjab), the infection was introduced on or about the 15th of October 1897. It became epidemic in the beginning of December following, viz: after one and a half months.

(9) At Bhajjal, Panjab  
(1898.)

(9) At Bhajjal (Panjab), the infection was probably introduced on or about the 1st February 1898. It became epidemic on the 21st of that month, i.e., after three weeks.



IX. The entire course of the epidemic.

In Southern China the epidemics of 1894-98 reached their climaxes in less than three months, and then declined rapidly, and within a short time were practically over, there being only a case now and again thereafter.

At Hong Kong

In Hong Kong the first signs of the epidemic of 1898 appeared at the end of February and a little later at Canton. By the middle of July the mortality in both was diminished. (Vide Indian Lancet of July 16th 1898, page 83.)

At Canton.

In Canton, plague made its appearance in the month of March 1894, and then took an unchecked course. No precautions were taken to cut it short. Its virulence had burned itself in a few months and then disappeared as rapidly as it had come, carrying away  $\frac{1}{10}$  of the population, i.e., about 100,000. For four years there was no epidemic of plague, except a case here and there, now and again. In March 1898 it again reappeared.

In India.

1. Karachee.
2. Bombay.

Karachee had a second outbreak in 1897-98.

Bombay is having its fourth recrudescence now by the end of 1898.

From the Panjab it has not disappeared yet. Rahon is infected still. (December 1898).

3. Calcutta

From Calcutta it seems that Plague disappeared within eight months after the date of the first authenticated case.

4. Hush-  
iarpur.

Our experience in the Hushiarpur District is that the average Sporadic period for seven villages under my care, was thirty-four days: and the average period of the active part of the epidemic for nine villages was 36.44 days. (Vide paragraphs six and seven of Section 2, Part II).

X. Varieties  
& Symptoms.

In the Article on Plague in Quain's Dictionary of Medicine, three varieties are mentioned.

Quain.

1. Larval or Abortive.
2. Grave.
3. Fulminant.

This division is based on the severity of the disease, dependant on the quality and quantity of the plague poison generated by the Plague Bacilli, rather than on any morphological differences in the Plague Bacilli concerned in each variety, for they are identical in each.

1. The Larval variety.

Dr Cantlie.

From the experience recently gained about plague in India and Southern China, it appears that towards the onset and decline of an epidemic, the Larval, Abortive, Ambulatory or the mild form of plague prevails. The cases then are mild, ill-defined, of long duration, often hardly noticeable, and as a rule all recovered from.

Personal observation.

At Birampur the Sporadic period, as stated above, was six weeks at the outset. During this period mild cases of the above nature occurred in the village. I was able to obtain the history of one of them. Namely of Rahmat Ali, aged 14 years, a Muhammadan high class (Rajput). He stated, and his elders confirmed it, that he had



had a swelling in his right groin, with a slight fever and local tenderness, which lasted for several days. I could not get any dates, but the boy was quite well before the 10th of December 1897, when the disease was raging in the village in an epidemic form.

Then towards the end of the epidemic I saw four cases of this mild type.

(1) Ghulam Muhammad, aged 18 years, felt slightly ill, had headache, sore throat and slight fever on the evening of 26th January 1898. On the 27th morning his temperature was normal, and he was going about. The throat was still congested, deglutition was difficult, and the tongue coated white. In the evening his temperature became  $101.4^{\circ}$  F. and the sputum had Plague Bacilli in it. On the 28th the bubo developed below and behind the left ear. Thereafter the febrile symptoms disappeared for good and the bubo gradually re-absorbed.

(2, 3, 4.) Three other cases of the same nature occurred in this boy's family, and were recovered from.

All these cases were so mild, that had it not been for our daily morning and evening roll call and medical inspection of all persons in the

segregation camp, we would never have known anything about these mild cases.

## 2. The Grave variety.

2. The Grave and Fulminant cases occupy the intermediate period of the epidemic.

The Grave cases are those in which all the symptoms of plague are pronounced and severe and in which the onset of the disease is practically sudden.

In the middle of his work, the patient is suddenly seized with a headache, a feeling of cold, sometimes amounting to a rigor, pains in the limbs and back, and either nausea or actual vomiting.

This stage is followed within half an hour or so, with a sudden rise of temperature, often as much as  $103^{\circ}$  F., and even  $105^{\circ}$  F.

The patient already feels so weak, that he takes to his bed at once.

Within a few hours, or it may be at the same time with the fever that one of the glands is found acutely tender and somewhat swelled. It may be in the groin, axilla, or below and behind the ear of one side or the other. At first the gland is hardly perceptible to another's touch, but the pain is there, so acute that it may be looked upon as quite diagnostic. It is

elicited by the gentlest touch, even when the patient is apparently unconscious and comatose.

The restlessness of the patient is severe; he tosses from side to side his arms and his legs and his head, attempting sometimes to sit up, and then falling back in the bed.

The face looks anxious and the patient shows by his appearance as if he was already doomed. No words of comfort seem to be believed. This look of anxiety soon changes into one of despair, and finally of apathy. The patient now lies on his back for longer intervals than before, with eyes half opened, the eye-balls rolled up, very little of the black showing - the appearance being that of midway between sleeping and waking.

The colour of the face is slightly cyanotic, the conjunctivæ injected, the tongue coated and the general condition as of one greatly exhausted and fallen into a state of utter prostration. And yet the patient is awake, and knows what is going on around him. He understands what is said to him, but either has not the power to answer, or does not care to be bothered. He is so anxious to get even one wink of sleep. In this state he is often heard muttering something to himself, every now and then opening his eyes



with a start, when he again tosses about his arms and legs and head for a while, again to dose off once more in a muttering condition.

In some cases the delirium is quite violent and the patient tries to get up and run out of bed, staggering about like a drunkard, with eyes half shut, and the face looking like one under the influence of opium.

In this condition he may pass away suddenly, or he may have his desire of sleep satisfied and he may go off into a good sound sleep, from which he may wake up quite refreshed; anxiety gone from the face; face brighter and more hopeful; the tongue more moist and the fever quite gone, the temperature being either at normal or even sub-normal. In some cases this sudden fall is attended with great danger, the patient dying from syncope at the slightest exertion, even when otherwise appearing quite hopeful.

In most cases that recover, the temperature falls only to about 100° F., and thereafter gradually becomes normal.

3. In Fulminant cases the attack is so sudden that before much can be done in the way of Medical Treatment, the patient has died off. I saw no live case of this kind at Birampur, etc.

3. The Fulminant variety.

As a rule I only saw the corpses. The Post-mortem appearances testified to the rapidity of the disease, the bodies being just as if they had been in health, looking as if the deceased was in quiet sleep during health. I was not at liberty to make regular post-mortem examinations owing to the unwillingness of the guardians, who in India, look upon such examinations as "Desecration of the Dead." Externally, as stated above, there may be no appearance of any disease. In some cases I found the tongues coated, the eyes injected, and one or other of the superficial lymphatic glands slightly enlarged.

The following instances at Birampur may be noted.

(1) Mukabar, aged five years, a female child, was quite well on the 20th December 1897 in the evening. Next morning she was a corpse, and round it were found the mother and a brother sickening for plague. The corpse showed no external signs of plague.

(2) Fattu, male, aged thirty-five years, was on the evening of 5th January 1898, taken ill after returning from work, with a feeling of cold and feverishness. Next morning he was found dead in his hut. There was no bubo. One of the

Examples of  
the Fulmin-  
ant variety  
at Birampur.

femoral glands was excised and examined, but the result was a doubtful one.

(3) Rahmi, aged ten years, a girl, was quite well till the evening of 7th January 1898, when she became suddenly feverish and was found dead by next morning. Her body looked fresh and plump. Her tongue was coated, and there was a small bubo in her right groin. It was examined and found to contain plague bacilli. Round the gland, while making the excision, I found present there a slight pinkish discolouration of the cellular tissues. The gland substance was of normal appearance and looked simply enlarged, but not congested.

(4) Roshan Ali, aged ten years, was taken ill at 5 a.m. on the 25th January, and died the same afternoon. He is said to have had, in the morning, shivering and vomiting followed by fever. On post-mortem inspection I found a small bubo in the right groin. It contained plague Bacilli. His pupils were dilated, but equal. The tongue was coated. There was some mucous froth at the nostrils and contained Plague Bacilli.

(5) An infant aged fifteen days, was well the whole day on 28th January 1898. In the evening he had convulsions and died within a few



hours. On post-mortem inspection I found no bubo. But there were large purplish patches of discolourations on the thighs and legs, (Inner surface). There was a bloody discharge from the urethra. This contained Plague Bacilli. The pupils were dilated and equal. At the nostrils there was froth containing Plague Bacilli.

Some Statistics of symptoms according to Dr James.

Dr James states that the onset of the disease is ushered in with shivering and a general feeling of being ill, and with the rapid onset of fever. In Khankhanan out of 175 cases there was a record of vomiting in 53 at this stage of the illness. In 82 cases severe frontal headache was complained of, and there was subsequently marked delirium in 50 cases. Coma or rather a semi-conscious apathetic condition existed in most of the cases.

Special symptoms.

The above is a general description, but the symptoms are so varied, that it is necessary that in the next place we should view some of the symptoms separately. Let us consider them in the following order:-

- (1) The bubo.
- (2) The fever.
- (3) The nervous system
- (4) The circulatory system.

- (5) The digestive system.
- (6) The urinary system; and
- (7) The skin and subcutaneous tissue.

(1) The  
bubo.

(a) Its  
position.

The following table shows the relative positions of the bubo, as well as the number of cases in which no buboes were developed.





The following table shows the relative position of buboes, as well as the percentage of fatal cases among them - at Jullandhar and Hushiarpur combined.

Buboes in the neck	10.87 p.c. of cases	Fatal 62.35 p.c.
Axilla	10.97 "	" 63.27 "
Inguinal	37.45 "	" 55.46 "
Femoral	15.98 "	" 61.86 "
More than one situation	4.44 "	" 69.23 "
Other situations	1.66 "	" -
No buboes	16.63 "	" 70.04 "

The time of its appearance.

The bubo may appear at the same time as the fever. Sometimes it may be the first symptom. As a rule it appears from a half to six hours after the onset of the fever. Sometimes it is delayed for two or three days.

In one of the Birampur cases there was no bubo in the first attack, but it was present during the relapse. This was the case of boy Rahmat Ullah, aged 3 years. He was attacked on the 24th of December 1897 at mid-day, when his temperature was found to be 104.4° F. On the 26th his temperature

(b) The time of their appearance.

came down to normal in the morning. In the evening it went up to 100°.4 F. On the 27th it was 97°.8 F. in the morning and 98°.4 F. in the evening. On the 28th the fever went up again, being 103°F. in the evening. On the 29th the temperature kept up between 102° and 102°.6 ; and it was on this day in the evening that the bubo made its appearance.

The second rise of temperature in this case in my opinion was a relapse; but if it should not be considered a relapse, then in this case the bubo made its appearance on the 6th day of the disease.

There are some cases, however, in which there is no bubo from first to last; and these are either cases in which there is pneumonia from the very first, or are cases in which the toxic symptoms are so violent that the patient is carried off before the bubo has had time to develop. None of the pneumonia cases under my care, save one, had a bubo. The one who had it, developed pneumonia secondarily. The cases in which death occurred within a few hours after the onset of the disease, had, except in one case, no bubo at all.

Dr James gives the following particulars as to the time when bubo appears, in 47 cases, treated by him in the Jullandhar District.

Cases without the bubo.

Dr James' observation in Jullandhar District.

In 4 cases, the glands appeared within an hour;

" 5	"	"	"	2 hours;	
" 8	"	"	"	3	"
"12	"	"	"	4	"
" 1	"	"	"	10	"
" 2	"	"	"	12	"
" 1	"	"	"	24	"
" 1	"	"	"	36	"
" 1	"	"	"	48	"
" 1	"	"	"	72	" and
" 1	"	"	"	96	"

(c) The size and shape of the bubo.

#### The size and shape of the Bubo.

The size varies from that of a small almond to that of a walnut.

When effusion takes place round the gland the size appears very large.

Before the incidence of this effusion the gland is well defined, and it is moveable.

If the patient survive, by the sixth day the bubo is as large as a walnut. After this it either begins gradually to re-absorb, or it may suppurate. In the latter case, the size begins to increase, owing to suppurative process extending to the surrounding tissues. In the course of this process pus may be absorbed into the general system and death take place from septicaemia. In favourable

(d) Suppuration in the bubo.



cases the buboes point and burst, when a running sore is the result which takes a long time in healing.

(e) Sloughing of the bubo.

Sometimes the bubo sloughs away leaving deep ulcer, which has white, unhealthy edges.

(f) Effusion round the bubo.

Effusion of blood around the bubo and inside it takes place at about the third or fourth day of the disease; and it is sometimes very extensive. In one case at Birampur it extended from the axilla almost down to the crista ilia of that side (Kanhaya's case).

The colour of skin over the bubo.

According to the extent and nature of this effusion, the colour of the skin over and around the bubo varies. The circumference is dark purplish, becoming gradually fainter and lighter towards the centre.

It was this variety of colours which led the ancient Indian Hakims to divide plague into red, yellow, greenish, bluish and black bubonic plague (Vide Hakim Sharma's pamphlet on Plague quoted above).

(g) Pain in the bubo.

The pain in the bubo.

This is very acute. In the early stages the pain is felt only on pressure. But when effusion takes place in and around the bubo, the pain is cutting and constant. When suppuration commences in the bubo, the pain is of a throbbing character.

This acute pain in the bubo from the very first, even when the gland can hardly be felt, is very characteristic and along with other symptoms is quite diagnostic. In the case of Ishar Jat of Bhajjal, I could not feel the bubo in the morning of 21st February, but the slightest pressure on the place of the incipient bubo caused wincing.

(h) The number of buboes.

The number of buboes.

As a rule there is only one bubo, sometimes there are two, and very rarely three. Among the 4,746 cases enumerated above under head situation, only 269 patients had more than one bubo.

(i) Sudden disappearance of bubo.

The sudden disappearance of a bubo, before any of the other symptoms have subsided is a dangerous symptom. This happened in Ishar, Khivi and Kallu Chamar at Birampur. With the disappearance of the bubo the attendant pain also disappeared; but the fever became worse and Ishar and Kallu both died from this cause.

(j) Post-mortem subsidence of bubo.

In connection with the subject of subsidence of plague bubo, I may note that post-mortem also buboes become greatly reduced in size. This is due to the action of gravity, the blood-vessels of the part which were <sup>distended</sup> during life, become comparatively emptied out and hence the diminution in size.

Unless there was extensive haemorrhage round the inflamed gland, I have found on dissection only a pink, bloody discolouration of the cellular tissues around the gland.

(2) Fever.

(2) Fever.

As a rule, the rise of temperature is synchronous with the establishment of the other symptoms of the plague fever. I have found it to register at 103°F., although the patient was either feeling simply cold and shivery or was quite unconscious of being feverish.

On the other hand, the rise of temperature at this stage may be very slight - 99 to 100°F. only.

In some cases the temperature at this juncture may be subnormal, being often 97 to 98°F.

I believe it is this last variety of cases in which there is rigor and great feeling of cold.

Within a few hours (1 to 6) the fever becomes established and then the temperature, as a rule, is between 103 and 104°F., and the sense of cold is replaced by burning and hot sensation all over the body, but especially at the pit of the stomach.

There is in this fever, as in all others, an evening rise and morning fall. At first the variation, however, is very slight - perhaps half a degree or even less. In severe cases the temperature



rises to 105° and over by the second or third day, and either carries off the patient by that time or he may linger on, the temperature remaining between 103 and 105°F. until the fourth or fifth day of the disease, when he may be carried off quite exhausted.

In favourable cases, it may then take a downward course, either gradually or at once - i.e., by lysis or by crisis.

The former variety (Lysis) are more favourable than the latter. In the case of a sudden fall to normal and more so when the fall is to 97 degrees, the danger of death by collapse is very great. Many a patient for want of proper nursing has been carried off at this stage.

When the sudden fall is to 95°F. or even 96°F., it is an indication of impending death, especially when all the other symptoms (stupor and dry, parched tongue) are unaltered.

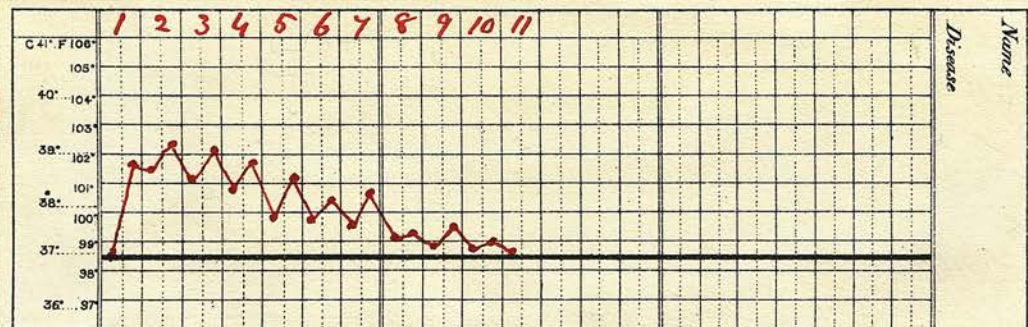
But about the cases in which there is even with this fall a return of a clear mind and moistness of tongue, and there is good nursing and careful supporting of strength by suitable stimulants, hope of recovery need not be given up. Such patients are less restless than before and show a tendency to go off to sleep, both of which are good signs.

In some cases the temperature never rises above 101 or 102°F., and yet the disease may be as deadly as otherwise.

Dr James remarks on fever as follows:-

Fever. This was always present in the early stages of the disease, and usually ranged between 102 and 105. A temperature of 106° was several times recorded during the epidemic. The following chart has been prepared as an average temperature record of 50 cases of plague. (In it, for the sake of convenience, he has not shown the sudden ending by crisis which, he states, often takes place between the third and fifth day).

Temperature Chart.





(3) The nervous system.

(3) The nervous system - symptoms of in plague.

The plague face.

Restlessness and delirium (muttering)

The effect of this poison on the central nervous system is marked. The patient from the very first is struck down so to speak with fear and a sense of great danger. This is followed by a semistupor, which has quite a diagnostic value. The patient looks sleepy and as if under the influence of some narcotic. He is dull, has photophobia, and a certain degree of deafness. His speech becomes slow and somewhat measured. This state has been compared in India with the state of "being drunk." The eyes are drawn up, half closed, the facial expression dull and apathetic, and the patient when he tries to get up, staggers, reels and falls down. There is great muscular weakness and early prostration.

Then there is great restlessness, the patient keeps turning from side to side in bed, tossing his arms and legs, raising his head as if trying to get up and then helplessly letting it drop down on the pillow. There is moaning and pathetic groaning the whole time during this restlessness. In between these recurring fits of restlessness there is delirium, although the patient is trying his best to go off to sleep, which sleep alas! does not come.

Sometimes the delirium is quite violent, the



Violent  
delirium.

patient trying to get out of bed and run out. In this state he may suddenly fall down dead.

Kallu Chamar of Birampur became very violent just before death. His bed had to be turned upside down, on which, thus brought down so near the ground, he had to be held down forcibly.

Paralysis.

In three cases at Birampur there was paralysis, being in the soft palate in the case of boy Saadat, and in the deltoid muscle in the case of Kallu, Sweeper. The latter had also aphasia. The third had only aphasia.

Insanity.

I have only seen one case of insanity as a complication, in otherwise a mild case. This was the case of Mahna, whom I found nearly collapsed through sheer exhaustion from wandering about from place to place. He had finally fallen down by the side of a road outside Garhshankar town.

Syncope  
from cen-  
tral toxin  
poisoning.

The cases of rapid and sudden death are due to the stoppage of the heart, due probably to central poisoning with the plague poison. This has been suggested by Dr James (Deputy Sanitary Commissioner, Panjab), and in this opinion I agree with him entirely. The heart itself has been examined in Bombay and scarcely ever found to be altered.

(4) The circulatory system.

(4) The  
circulatory  
system.

The danger of syncope has been alluded to above. Sometimes when everything seems to be

Syncope.

going on favourably, death may take place from this cause suddenly - even sitting up in bed may bring it on.

Heart sounds and pulse.

The first sound of the heart soon becomes weak and inaudible, and the apex beat feeble. (Quain). (The pulse is feeble, small and quick even on the second day of the fever. At the outset even it is weak and easily compressible, although full and bounding). In some cases from the very first the pulse is quick and feeble (110 to 120 per minute). The early compressibility of the pulse is characteristic of plague.

Haemorrhages.

Haemorrhages take place in this disease in and around the bubo. Sometimes the haemorrhage is extensive and may extend into the subjacent muscles, etc. At other times haemorrhages (small or large) take place under the skin and in it, in parts other than at the site of the bubo.

The infant child of Moula at Birampur had large purpuric patches on the internal aspects of both legs and thighs, as well as haemorrhage from the urethra.

Chhajju of Purkhowal had haemorrhage under the skin on his chest and neck.

Haemorrhage from the lungs is the rule almost in pneumonic forms of plague. I have only seen three cases out of fifteen of primary plague,

pneumonia, in which there was no haemoptysis. The blood expectorated is very thin, and does not coagulate quickly.

(5) The digestive system.

(5) The digestive system.

Thirst.

Coated tongue.

Anorexia.

Nausea and vomiting.

The bowels.

Thirst is intense and there is great longing for cold drinks. The tongue is parched and coated.

This coating is characteristic when well formed. It looks then as if covered with a creamy-yellow fresh lymph. The tip and the edges are bluish red.

There is complete loss of appetite, nor indeed can the patient retain anything.

There is nausea and vomiting present, in most cases at the outset of the disease only; but in some it is persistent. In the latter class of cases, as a rule, it is fatal.

The bowels were found in most cases constipated at Birampur and Purkhowal.

Among 71 cases treated at these two villages, there were only 4 cases of diarrhoea, whereas there were 9 cases of persistent vomiting.

(6) The urinary system.

(6) The urinary system.

Suppression of urine.

In only one case there was suppression of urine, and that, too, not at either Birampur or Purkhowal. It occurred in the woman named Uttam Devi at the village of Jandiala. It lasted for



24 hours, when free micturition was afterwards re-established by the use of diluents.

Albumin in urine.

A small quantity of albumin is said to be present in the urine of plague patients, but only sometimes.

Sodium chloride, etc., diminished.

The quantity of sodium chloride is said to be diminished; urea is diminished also. The reaction is intensely acid, but it soon changes and the urine becomes decomposed. The sp. gravity varies from 1010 to 1035; and casts, epithelium and blood, etc., may also be present. (Vide "The Urine in Plague," Hojel, Medical and Physical Society of Bombay, 1897).

Acid reaction.

#### (7) The Skin.

(7) The skin.

Dr James thinks that the skin is always perfectly dry. In the Hushiarpur epidemic however, I did not find it to be universally the case. I found the axillae of Musst Sakina of Birampur moist; and Musst Khivi used to have profuse perspiration of head, neck and upper part of the trunk.

Dry skin not the rule.

Subcutaneous haemorrhages.

Subcutaneous haemorrhages have been alluded to above.

Boils and abscesses.

Boils and small abscesses may appear towards the convalescent period. Among 71 patients I only found boils in two and small abscesses in two.

Rash in plague rare

Rash of the papular kind was seen only in one

case, namely, in Saadat. It came out on the seventh day. The papules were small, of the size of a small lentil seed, round, <sup>with</sup> red bases and mounted by acuminate white heads. They came out in one crop and were found on the abdomen, chest, arms and legs. By the third day, they dried up. On their first appearance, the guardians of the patient thought that the boy had small-pox.

No carbuncle seen.

I have seen no case of carbuncle.

(8) The generative system.

(8) The generative system.

Pregnant women when attacked with plague usually abort and die, owing to the loss of blood which of necessity must attend abortion. One such case was seen at Birampur, namely, Musst<sup>†</sup> Natho. She was found ill on 19th December and died on 21st morning idem a few hours after the miscarriage.

(9) The eyes.

(9) The eyes are congested as a rule, and there is photophobia in all. In one case (Bhulla) at Birampur there was acute conjunctivitis and in one there was ulceration of the cornea following conjunctivitis.

XI. Prog-  
nosis.Prognosis.

It is mostly very uncertain, owing to the great effect the poison of plague has on the heart. The patient may die suddenly from the effects of any slight exertion - a sitting up in bed suddenly, for example. This tendency to syncope is present from the first and has to be guarded against even during the convalescence stage.

Danger of  
syncope.

Case mor-  
tality.  
In Hong  
Kong.

We must remember that the case mortality in plague is very high. In Hong Kong in 1898 it was 88 p.c. (Vide Indian Lancet for 1st June 1898).

At Karachee

At Karachee in 1896-97 it was 80 p.c. (cases 6,439; deaths 5,182). (Vide The English Lancet for September 24th, 1898, page 821).

China and  
India.

Surgeon General Harvey has stated that the case mortality in China in 1894-96 and in India 1896-98 has been 70 to 90 p.c. (Vide Quotation from the Government Gazette of India as quoted in the Indian Lancet for 1st June 1898).

Bombay.

Up to 22nd November 1898, there have been in the Bombay Presidency 187,922 cases with 148,181 deaths from plague since September 1896. (Vide Pioneer Budget for November 25th, 1898). This gives 78.85 per cent. as case mortality.

Panjab.

In the Jullandhar and Hushiarpur Districts in 1897-98 there were 3,469 cases with 2,176 deaths.



(Vide Dr James' report on the plague in the Panjab, 1897-98).

This gives a case mortality of 62.44 per cent., in spite of all the precautions taken (sanitary and medical).

At Hushiar-  
pur in  
cases with  
buboes.

Judging from the experience gained at Birampur and Purkhowal, I am of opinion that the cases in which there is an early appearance of the bubo, mortality under the present English treatment is less than when there are no buboes, or when the bubo appears late. The appearance of a bubo on the fifth or sixth day of the disease, in my opinion, means a second infection.

In cases  
with cere-  
bral or  
lung com-  
plication.

In the cerebral form, i.e., the variety in which the brain suffers the brunt of the attack, and the form in which lungs are the organs chiefly attacked by the plague virus, our prognosis must be extremely guarded. The primary pneumonic cases rarely survive, especially when attended with haemoptysis. At Birampur, none of the haemoptysis cases survived. The same has been the experience at Bombay and Hong Kong.

In cases  
with vomit-  
ing and  
purging.

Excessive vomiting and purging are also very unfavourable signs. As a rule, they too are almost always fatal.

If the 4th day is successfully gone through.

If a patient struggles through an attack for four days, his chances of recovery are greater than it could have been said of him earlier.

Some figures showing the days of the fever on which death supervened.

In the following statement are compared the figures furnished by Colville (as found in Quain's Dictionary of Medicine) and the figures furnished by Dr James in his Report on Plague in the Panjab in 1897-98, showing the number of deaths which occurred on the different days of the disease in the different patients under their care.

The day of the disease.	The number that died.	
	After Colville	After Dr James
1st day of fever	126	207
2nd "	80	266
3rd "	105	221
4th "	76	209
5th "	60	136
6th "	26	139
7th "	12	107
8th "	14	54
9th "	-	31
10th "	14	21
11th "	-	17
12th "	9	9
13th "	-	7
14th "	-	2
15th "	1	2
16th "	-	4
17th "	-	2
18th "	-	4
19th "	-	1
20th "	11	-
21st "	-	3
22nd "	-	1
23rd "	-	-
24th "	-	3
25th "	-	-
26th "	-	1
The date of attack unknown	-	261
Total cases	514	1708

Early taking to bed.

The patient who has taken to bed early in the attack, has a better chance of recovery than one who has not done so. The former reserves his strength for the fight, the latter has already expended a fair amount of it in walking about, etc.

Effect of obesity.

Dr James states that very fat people pull through with greater difficulty than those who are not obese.

Age.

Very young children and old people are the least <sup>likely</sup> likely to an attack, but when attacked are the least likely to recover.

The following table is based on a very small number of cases, but it is put forward here for what it is worth.

				Cases.	Deaths.	Case mortality.
Under 1 year				1	1	100 per cent.
1	"	5 years		7	3	43 "
6	"	10 "		7	5	71 "
11	"	15 "		8	3	37 "
16	"	20 "		11	7	64 "
21	"	25 "		10	4	40 "
26	"	30 "		6	5	83 "
31	"	40 "		5	4	80 "
41	"	50 "		12	11	92 "
51	"	60 "		2	1	50 "
71	"	80 "		1	1	100 "
Total				70	45	64 "



If the above ratios should prove to be the same in a larger number of cases, we may infer that the years 11 to 15 are attended with least death rate (37 per cent. of cases); then come in the same order the following quinquennial and decennial periods:-

21 to 25 years	40 per cent.
1 " 5 "	43 "
51 " 60 "	50 "
16 " 20 "	64 "
6 " 10 "	71 "
31 " 40 "	80 "
26 " 30 "	83 "
41 " 50 "	92 "
71 " 80 "	100 "
Under 1 "	100 "

If the age periods be viewed as consisting of twenties, case-mortality for each period will be as follows:-

	Cases	Deaths	Case-mortality.
Up to the age of 20 years	34	19	55.9
21 to 40 years	21	13	62.0
41 " 60 "	14	12	85.7
61 " 80 "	1	1	100.0

From these figures it would appear that the age most liable to an attack of plague was between 1 to 20 years, but that it was also the least fatal. Secondly, that as the age advanced, the tendency to attack decreased and to death from it increased.

Cabiadis found the ages of 1826 cases at Hillah as follows:-

Up to 19 years	-	894
20 " 39 "	-	724
40 " 59 "	-	175
60 " 79 "	-	29
80 " 99 "	-	3
Over 100 "	-	1

Influence  
of sex and  
caste in  
the Panjab.

The following table shows the sex and caste of those attacked with plague in the Jullandhar and Hushiarpur Districts (compiled from Dr James' Report on Plague in the Panjab) 1897-98.

Sex		In Jullandhar	In Hushiarpur	Total.
	Number of males attacked . . . . .	1122	295	1417
	" females " . . . . .	1160	267	1427
	" males under 10 years . . . . .	224	82	306
	" females " . . . . .	196	59	255
	Total number of sexes	2706	703	3409
Caste Hindu	Brahmans and Khatri . . . . .	294	217	511
	Jats, . . . . .	854	29	883
	Tarkhan, Lohar, Chhimba and Sunars . . . . .	179	23	202
	Jhinwars, . . . . .	50	15	65
	Nais, . . . . .	21	11	32
	Ghumars, . . . . .	10	89	99
	Acharaj, . . . . .	4	1	5
	Faqirs and Beggars, . . . . .	18	-	18
	Rajputs, . . . . .	146	4	150
	Total of Hindus	1576	389	1965





Effect of  
nationality.

Nationality seems to have no effect. The escape of Europeans during the epidemic of 1894-96 in Hong Kong was due to their better mode of living, than that of the Chinese who lived in the midst of filth, in badly ventilated houses.

Early re-  
moval from  
an infected  
house.

The patient who has been removed early from the infected room to a well-ventilated room has a better chance of recovery, than one removed later and considerably more than one not removed at all. This has been proved to demonstration in the Jullandhar-Hushiarpur Epidemic of 1897-98.

Effect of  
evacuation  
of an in-  
fected vil-  
lage.

Dr James has shown the effect of evacuation of infected villages by tabulating in his report on the Panjab epidemic the dates of evacuation and the number of seizures before and after. He rightly draws the following conclusions, which are just what we obtained in the Hushiarpur District - (Vide page 116 of his Report). "We may preface our remarks by saying that, as far as we know, no epidemic of plague, however mild, has ever been known to die out naturally in any locality under four or five months, and in most records it is very much longer than this." . . . . . In the Jullandhar District 75 villages were evacuated as soon as practicable after plague was discovered in them. In the Hushiarpur District 16 villages were similarly

evacuated. In the former set, during the first four days after evacuation, there was an actual increase in the number of cases. This was due to two reasons - (i) "The effect of evacuation would not show itself at once, because a certain period exists between the time people caught the infection and the time the first symptoms showed themselves. This period varies, according to the statements made by the medical officers in Bombay, from 1 to 10 days. So that a community being infected in the village and then leaving, would show cases from 1 to 10 days afterwards." In Jullandhar this period seemed to be 5 days for a vast majority of the cases.

(ii) The people in these villages were foolish enough to hide cases. Many of these hidden cases were discovered after evacuation and had to be shown as new cases to prevent confusion in the daily returns of cases for the previous days.

"From the 5th to the 20th day (after evacuation) a rapid and almost continuous decrease" in the number of new cases took place. After the 20th day, the few dropping cases that occurred "were due to other causes, such as people surreptitiously entering the village." In other cases, the poison was contracted during the disinfection of infected houses.



The following are the totals of Dr James'

Table No. IV.:-

		Julland- har.	Hushiar- pur.
Total number of villages evacuated		<u>75</u>	<u>16</u>
"	cases before evacua <sup>n</sup>	<u>1099</u>	<u>288</u>
"	" on the 1st day		
	after evacuation	155	95
"	" 2nd "	165	45
"	" 3rd "	183	38
"	" 4th "	189	31
"	" 5th "	120	34
"	" 6th "	94	24
"	" 7th "	77	18
"	" 8th "	61	8
"	" 9th "	49	4
"	" 10th "	28	12
"	" 11th "	32	10
"	" 12th "	29	5
"	" 13th "	11	3
"	" 14th "	26	2
"	" 15th "	27	5
"	" 16th "	26	2
"	" 17th "	26	7
"	" 18th "	17	4
"	" 19th "	21	3
"	" 20th "	<u>9</u>	<u>2</u>
Total of last 20 columns		<u>1345</u>	<u>365</u>
Total of cases that occurred after the 20th day of evacuation, .		<u>262</u>	<u>50</u>
Total of cases up to date, .		<u>2706</u>	<u>703</u>

Average  
period for  
the disap-  
pearance of  
plague af-  
ter evacua-  
tion.

Dr James' Table No.VI. is also interesting, as  
showing the number of days which elapsed between  
the date of evacuation and the date of the last case.

It gives the average for Jullandhar - 21 days.

" Hushiarpur - 26 "

XII. Sequelae and complications.

1. Anaemia.

2. Conjunctivitis.

3. Paralysis.

4. Insanity

Complications.

1. Pneumonia

1. Anaemia. This is very marked in all cases.

The colour of the skin assumes a darkish hue. The patient takes fully a month and more before the natural colour returns.

2. Conjunctivitis. This is present in most cases - varying from a slight injection of conjunctival vessels to acute inflammation. In one case at Birampur it ended in ulcer of the cornea.

3. Paralysis. There were only 3 cases in which Paralysis was seen at Birampur. In one (Saadat) it was the soft palate which was affected.

In 2 there was aphasia. Of the latter, one had the deltoid of the Bubo side paralysed.

4. Insanity. I have only seen one case of this kind. The patient, an old man, had wandered in this state from some village in the Jullandhar District. In our own District we did not have a single case of this kind.

1. Pneumonia. We only had one case in which this complication was developed - namely in the person of Kallu Chamar of Birampur. This happened on the third day of the plague fever and was therefore not an attack of primary pneumonia, the latter, as stated above under head "varieties and symptoms." ushering itself on the very first day of the plague fever.

2. Suppression of urine.

2. Suppression of urine is a rare occurrence.

I only saw one case in the Hushiarpur District, namely in the person of Uttam Devi of Jandiala. It lasted for 24 hours.

3. Septicaemia and Pyaemia.

3. Septicaemia occurs in cases in which the

Bubo is not incised or otherwise opened, after suppuration has set in it. I saw a good many instances of this at Hajipur, the patients of which village did not submit to our treatment.

Pyaemia.

Pyaemia. Among the 15 patients that recovered

at Birampur, 3 had pyaemic abscesses, namely Saadat, Rahmat Ullah and Bhulla. In them abscesses formed in some of the glands of the adjoining parts not far from the Buboos. They were all incised and hence no further crops of abscesses.

4. Miscarriage.

This is a very serious complication, as it almost always proves fatal.



### XIII. Diag- nosis.

The diagnostic symptoms of plague are:-

- (1) Sudden onset of disease.
- (2) The Bubo, acutely tender.
- (3) The coated tongue.
- (4) The Facial expression.
- (5) Contagiousness.
- (6) Early prostration.
- (7) Great Mortality.
- (8) Concomitant Rat murrain.

The Diseases from which plague may have to be diagnosed are:-

- i. Bubo of venereal origin.
- ii. Non-venereal, sympathetic Bubo in cases of wounds and excoriation of skin, etc.
- iii. From mumps.
- iv. From remittent fever.
- v. From pneumonia and pleurisy.
- vi. From typhus fever.

#### i. Venereal Bubo.

In venereal cases the fever of plague is absent, and the primary sore or gonorrhoeal discharge, as the case may be, present.

#### ii. Non-specific (sympathetic bubo).

In sympathetic bubo, the plague fever is absent, the wound, cut, or a festering sore is present.

#### iii. Mumps.

In mumps, both parotids as a rule are affected. In plague generally, the bubo is below and behind one of the ears only. The mump fever is not so

quickly prostrating as the bubonic fever. The plague bacilli are absent in mump fever. Bubonic inflammation of the parotid gland is rare. I have only seen one case among nearly 200 cases.

iv. Malarial  
remittent  
fever.

In malarial remittent fever, there is no bubo. It is not so quickly prostrating, is not contagious, and has not the plague bacilli in the system.

v. Pneumonia

In plague pneumonia the expectorations consist of very thin blood, which is a pure culture of plague bacilli. The ordinary pneumonia patient has not the same degree of restlessness as the one suffering from plague pneumonia. Mortality is not so high in the ordinary pneumonia, nor is it contagious in the same sense as plague.

vi. Typhus  
fever.

In typhus fever, the duration of the disease is, as a rule, very much longer than is the case with plague. In the latter, the greatest mortality is early in the course of the disease; in typhus it is after the first week of the disease. In typhus a peculiar mulberry-coloured rash appears - in plague rash is extremely rare and is of a different character (papular).

In typhus bubo does not, as a rule, appear, except now and again at about the end of the disease. In plague bubo appears early. Plague bacilli are not present in typhus fever.

XIV. Treatment.

(a) Specific.

Yersin's antiplague serum.

Preparation of his serum.

(1) Dr Yersin has discovered that the "anti-plague serum" prepared by him, when inoculated into a plague patient during the early stage of the fever, acts as a specific.

His serum is prepared from a horse by inoculating it with plague bacilli at frequent intervals, until the animal shows no reaction. This process takes about 6 months, and hence unfortunately its inconvenience.

The serum, prepared from such a horse, when inoculated into other susceptible animals, is said to protect them from contracting plague, and even to prevent a fatal issue, if the disease be already contracted.

This serum is preserved in bottles, each containing 10-20 cc. They must be kept in the dark and in a dry place.

The ordinary temperature of the air is said not to affect its quality. It contains no antiseptic or poisonous materials. It can be used without any fear of doing any harm to the patient.

Inoculation

It is usually inoculated under the skin of one of the flanks.

In making these inoculations all antiseptic precautions should be taken.

Each time the serum is used, it must be from a



fresh bottle.

Its full dose is 33cc. for an adult.

It is contra-indicated in kidney disease.

The fever and the bubo of plague are said to decrease as soon as the serum takes effect. If the first inoculation does not ameliorate symptoms, a second and even a third one should be tried, until the symptoms of plague begin to abate. The repetition of the injections may be practiced after the lapse of 12-24 hours after the previous injection.

The results obtained at Bombay not very striking.

The results obtained at Bombay however are not very favourable. There, in 50 selected cases, so treated, the results were no better than those obtained under ordinary Hospital treatment. Out of the 50 persons inoculated 17 died, giving the percentage of recoveries at 66 per hundred (Vide Dr James' report on Plague in Bombay in 1896-97).

Its use at Amoy.

At Amoy, in June 1894, he treated 23 cases with this serum, and cured 22 of them (vide page 84 of the Indian Lancet for 16th July 1898).

Professor Haffkine's antiplague medium, for inoculation

(2) Professor Haffkine's antiplague medium, which will be referred to in detail under head prophylaxis, is of no use once the fever of plague has declared itself in a patient.

Dr Lustig's  
serum.

(3) Dr Lustig's serum has been tried in Bombay and Dr Gallioti of that place reports on it as follows:-

(1) In pneumonic cases the results are negative - the serum is quite powerless.

(2) In septic cases the results are good.

Two injections were given on the first day in two cases. The plague fever was arrested; and there were no plague bacilli to be found on the second day, whereas they were present in the blood before the injection in both the patients treated with this serum, showing that these cases were serious ones and yet were cured so rapidly.

One of them was discharged on the ninth day and one on the twelfth day of the disease.

These injections should be made early in the disease - on the first day if possible: and that too during the early hours of the onset of the initial symptoms. (Vide Indian Lancet of 1st June 1898 page 576).

(4) In the way of drugs, no real specific has yet been discovered.

Dr Thomson of Bombay found in 1896 the free use of Hydrargyri perchloridi beneficial; but it cannot be said whether it was this drug or the rest of the general treatment of symptoms on rational

Perchloride  
of mercury  
in plague.

Experience  
of Dr  
Thomson.

lines, which contributed largely to the fair amount of success obtained at the Parel Hospital, Bombay.

One thing observed by Dr Thomson, in connection with the use of mercury in plague, is worthy of note, and points to there being some sort of definite curative relation between mercury and the plague poison. That one thing is the fact that so long as the poison of plague is in the system of a patient, mercury does not produce Ptyalism in him. So uniformly true he found this phenomenon in his practice, that he came to look upon it at last as a diagnostic point. Many a doubtful case of plague without bubo he decided to be one of plague after the application of this test.

The dose of the Liquor Hydr. Perchlor, for an adult is  $\frac{1}{2}$ -2 drachms, to be repeated every 6 hours.

Its use at  
Birampur.

At Birampur, I gave this drug a full trial and my opinion about it is the same as that of Dr Thomson. Fully 50 per cent. of the cases so treated recovered; and my conviction is that had all the patients submitted to this treatment from the very first, many more would have been saved.

I have stated that the use of mercury in this form was only an adjunct and that everything else also was done that I could think of, in coping with the symptoms as they arose in each case.



(b) General  
Treatment.

(5) I shall therefore give now a general outline of what should be done in the way of relieving these symptoms.

Rest in  
bed.

As soon as the patient begins to feel the initial symptoms (headache, chills, etc. ) he should take to his bed and not allow any of his strength to be wasted; this is to guard against syncope. His room should be freely ventilated, and he should not have more attendants than is absolutely necessary - one is quite enough as a rule.

Disinfection of  
body and  
clothes.

If possible, his body should be at once sponged with tepid mercury lotion ( 1 in 1000). All his clothes should be changed (and those taken off placed in mercury lotion).

Attention  
to the  
bowels.

The bowels should next be seen to. If constipated the following pill may be usefully administered - Pil. Rheico. gr.  $2\frac{1}{2}$  + Pil. Hydrarg. gr.  $2\frac{1}{2}$ .

If the bowels are loose, they should be regulated with the mixture of chalk combined with tincture of opium and a little peppermint water. In some cases acid sulphuric dilute in peppermint water is sufficient.

If there be only two to three actions in the 24 hours, no medicine is needed. It is best to let the bowels become emptied naturally, as their irritation with medicines may set up uncontrollable

Guarded use  
of opium.

diarrhoea. The use of opium must be guarded, because already in this disease congestions of various organs and viscera are present and are likely to be made worse with opium.

For (i)  
the fever.

Then as regards the fever, if it is not more than 100-102°F., no febrifuge is needed, the general management of the case is sufficient. But if the fever is high (103-105°F. or over) the best febrifuge is tepid sponging of the body, and in persistent high temperature wet pack in a cold sheet. Even 3 and 4 packs are necessary sometimes before the temperature shows signs of coming down. Care must be taken during these wet packs, not to lower the temperature down too quickly, as there is always a danger of syncope. This should be guarded against by giving half an ounce of brandy in water when the temperature has come down to 100°F., or when the patient complains of feeling very cold in the wet sheet.

Tepid  
sponging.

Wet pack.

Syncope to  
be guarded  
against.

The use of stimulants should be guarded, lest the stomach become upset. The best thing to do is to give them in small quantities at a time and only when needed.

Medicines.

In the way of medicines, as stated above, Liquor Hydrarg. Perchlor. is sufficient -  $\frac{1}{2}$  to 2 drachms every sixth hour for an adult. I found the

combination with it of Tincture Digitalis (2 m per dose), Spirit Chloroform (m XV per dose), and Liquor strychnia (m ij per dose) useful. These were suggested to me by Dr James.

(ii) The management of the bubo.

Belladonna and glycerine paint.

As regards the bubo, it should be painted over with Belladonna and glycerine, to relieve pain and to help its absorption. Dry, hot fomentations should be added, if the pain is very acute.

Excision of bubo.

As to the question of excising the bubo, it has been recommended, but I have not tried it in any case properly.

Incision of bubo.

I have however incised buboes of the patients that allowed me to do so. My opinion is that no bubo should be incised during the first three days of the fever, there is danger of re-infecting the patient. Incision on the fifth day seems free from this risk. The incision should be deep and free, in order that the wound may at once gape out well and the toxin-containing contents of the bubo drained away. If this is not done, there is the danger of forming a pouch under the skin, from which the toxins are liable to enter the general circulation through the open mouths of blood-vessels in the newly cut wound.

The inside of this wound should be thoroughly washed out with 1 in 1000 of corrosive sublimate.



lotion and iodoform dressing applied.

In the following statement are given the names etc., of patients in whom the bubo was incised at Birampur and Purkhowal.

List of patients in whom bubo was incised at Birampur	Bhulla	Cervical bubo	Incised on 13th day	Cured
	Saadat	Do.	9th day	Do.
	Douli	Inguinal	17th "	Do.
	Rahmat	Cervical	10th "	Do.
	Atar Bibi	Inguinal	1st "	Do.
	Pohlo	Cervical	14th "	Do.
	Kallu	Axillary	5th "	Do. Bubo shelled out.
	R. Khan	Inguinal	1st "	Died.
	Niamat	Axillary	7th "	Cured.
	Alla Ditta	Inguinal	19th "	Do.
	Ralla	Not noted	Not noted	Do.
	Ralli			
	Bhulla			
	Thakur			

The reason why I do not advise incising buboes early is, that there is ~~great~~ risk in it of re-infection (the toxins from the incised bubo finding their way into the general circulation), and as we cannot tell beforehand in which case such an

infection may take place it is advisable not to run the risk.

In the following cases I employed hypodermic injection of Liq. Hydr. perchlor. below the seat of the bubo. The quantity injected in each case was 50 m.

Hypodermic  
injection  
of Liq.  
Hydr.  
Perchlor.

Name.	Time of injection.	Result.
1.Kallu	On the third day of the fever.	His temperature before the injection was 100°F. He was aphasic. Next morning his temperature was 100.6. In the evening it became 99.2 and his general condition greatly improved.
2.Kanhaya	On the fifth morning.	He did not improve and died 3 days later.
3.Saadat	On ninth day.	His temperature before injection was 102.2. After the injection he slept well and next morning his temperature was 99.6. In the evening it went up to 103°F. Next morning it was normal and he finally recovered.

The number of trials given to this procedure is much too small to draw any inferences from. On the whole, I am of opinion that it should be tried whenever possible; for if anything it seems a useful adjunct to other medicinal measures. The idea is to allow the lymphatics of the bubo to take up this antiseptic and thus neutralize the toxins inside the gland.

(iii) Sleeplessness.

As regards sleeplessness, which is a very distressing symptom, it should be treated with applications of cold to the head and with the internal administration of Pot. Bromide and Chloral Hydrate in small doses (5-10 grs. of each). Larger doses are depressing, and in this disease the utmost care should be taken in no way to depress the patient's strength. For the same reason it is dangerous to give fever mixtures and antipyretics such as Antifebrine, Phenacetine, etc.

(iv) Delirium and Meningitis.

The same treatment that does for sleeplessness answers for delirium, meningitis and other head troubles. The hair of the head should be cut short and mercury ointment (Blue) should be rubbed on the scalp. Mustard plaster should be applied to the nape of the neck. The bowels should be kept regular with calomel and castor oil.

(v) For Paralysis.

For paralysis nothing special is needed, - the mercury prescribed in the antiplague mixture is quite sufficient.

(vi) Pneumonia.

In Pneumonia with profuse bloody expectorations no medicine has yet been found to be of any use. It is best, however, to try the internal administration of oleum Terebinth in 10-20 m doses. Hypodermic injection of ergotin should be tried, if turpentine fail altogether. The strength of



the patient should be kept up with alcohol and hypodermic injections of spirit. etheris. The chest should be rubbed with turpentine and oil and hot fomentations applied. I had no ice to try, but I think it should be applied to the painful part of the chest with a view to stopping the pulmonary haemorrhage.

(vii) Syncope.

When syncope threatens a quickly diffusable stimulant is needed and nothing is better than hypodermic injection of spirit etheris. Champagne may be given by the mouth in small doses. Amyle Nitrite may be given on a handkerchief and a mustard plaster applied to the precordia. The body should be kept warm by applying hot water bottles to the feet, the legs and the flanks. In fact, everything should be done to enable the heart to tide over the attack if possible. Above all, care must be taken to see that the patient is kept down on his back. He should not be allowed to suddenly sit up, which he is very apt to do in his struggles for breath.

(c) Dieting of plague patients.

Food. Lastly, great attention should be paid to the dieting of the patient. Nourishing, but fluid and easily digestible, food should be given in small quantities at regular intervals. During the fever stage the patient should only be kept on milk (2-4 3 every 2 hours or less often), or beef tea and milk

alternately. When this stage is over, egg flip (of the yolk of one egg) with a couple of drachms of brandy and 4  $\frac{3}{4}$  of warm milk, may be given two or three times daily. Later on milk pudding may be added to the dietary: and so on, other articles of diet may be allowed gradually and in small quantities according to the state of the digestive organs. Even during convalescence diet must be carefully regulated, as a relapse may take place at any stage through neglect of this precaution by setting up diarrhoea.

#### Drinks.

As regards the thirst of the patient, acid drinks made with lime juice or citric acid are very refreshing. Effervescing draughts are very agreeable if there is nausea and sickness. Pure water, barley water, Toast & water and aerated waters can all be given alternately according to the patient's fancy.

#### (d) Proper nursing.

In connection with the nursing of a plague patient, it must be remembered that the use of a bed pan is incumbent from the very outset of the disease. The patient must be spared all possible exertion to avoid an attack of syncope from weakened heart.

## XV.    PROPHYLACTIC    TREATMENT.

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(1) Haff-  
kine's anti-  
plague med-  
ium.

Professor Haffkine has prepared a weakened form of the Plague Toxines, which he is employing largely in India as a Prophylactic against plague. As stated above under head Treatment, this preparation has no curative power against the Plague fever.

It has certainly been found to reduce very considerably case mortality in a community in which plague is present.

Its nature.

Before giving details of his inoculations, it is necessary to state how this preparation is obtained. It has wrongly been called a "serum", for it is not a serum at all. It is the mixture of dead plague Bacilli and their attenuated toxines in a broth or bouillon, to which has been added a small quantity of clarified butter.

Its prepara-  
tion.

A flask containing sterilised Bouillon is inoculated with plague Bacilli. A drop of Ghee is added to it and the flask placed in an incubator in a room where there is not the least shaking of the floor. The room must be dark. After several days a white scum forms on the surface; and from it are seen hanging down little thread-like prolongations into the bouillon. They look like "roots of duckweed in water" or like "stalactites."



This bouillon is now shaken up when the threads break down and fall to the bottom of the flask and the broth becomes quite clear again. It is next heated for an hour at a temperature of 150° F., after which it is transferred to small phials which are at once sealed and put away in a dark place. The sealing up is accomplished by fusing the mouth of the bottles with a blowpipe.

The preparing of this fluid medium takes about 6 weeks.

Its dose.

The dose for an adult male 3 to 3½ cc. Less for  
" " " " " female 2 to 2½ cc. weakly  
persons.

" " " a child of 10 yrs. 1 cc.

and " " " " " 3 " 0.1 to 0.3 cc.

The second injection should be made after 10 days, the quantity to be injected being varied according to the reactionary symptoms following the first injection - a smaller quantity being needed if the first symptoms were severe. The best place for this Hypodermic injection is one of the flanks, where the skin is loose and an injection can there be made quickly and almost painlessly.

The syringe to be used, should be some kind of aseptic serum syringe with a long needle and marked with cc. and their fractions.

Reactionary  
Symptoms.

(1) My personal experience is very limited. In March 1898 at Bunga, while learning inoculation work, I did 25 cases under the supervision of Dr James. I have no notes about them, but they are included in his own figures quoted further on.

(1) Personal  
observations.

On this occasion I saw a large crowd of patients who had come to show themselves and their puncture marks, etc., to Dr James. All I saw were looking very well - they had been inoculated during the past week. Those done recently had their tongues still plague looking and the site of the puncture swelled, raised and red. Some of them had small buboes with characteristic pain of plague in them. These were not necessarily situated near the point of inoculation, but some in the groin and some in one or the other axilla. Some stated that they had had only a slight fever during the first 24 hours after the inoculation, and some very severe with headache and nausea.

(2) Dr Sar-  
badhikari's  
observations

Dr Sarbadhikari of Calcutta has given the results of his observations in 43 cases (Vide Indian Lancet for 1st June, 1898).

(1) There were no symptoms for 3 to 5 hours after the inoculation.

(2) Then there was feverishness, more or less

pain and redness at the site of the puncture.

(3) After 10 to 12 hours, the fever was pronounced in every case; it ranged from  $100^{\circ}$  to  $103.4^{\circ}$  F.; and it lasted for 20 to 34 hours.

In a few cases it was accompanied with headache, general aches and pains. One person had nausea.

(4) Fourteen hours after the inoculation a distinct hardness was noticed round the puncture.

(5) After 41 hours.

(a) All but one, were free from fever.

(b) The pain gone in 10 persons, unbearable in 1, and bearable in the rest. The man with the acute pain here referred to was the same whose fever was at  $103.4^{\circ}$ , mentioned under head 3 above). (It is now  $99.8^{\circ}$  F.)

(c) The majority - i.e., all but one with the high fever - never gave up their work.

(d) All were kept on low diet.

(e) Some complained of a sense of a general weakness (owing perhaps to the low diet.)

(f) None of the cases gave any cause for serious anxiety.



(3) Dr James' experience in the Jul-landhar District in 1897 - 98.  
Fever.

In all successful cases of inoculations with Professor Haffkine's Anti-plague medium, the average temperature of reactionary fever ranged between 100° F., and 103° F., lasting for about 2 days.

Swelling at the site of puncture.

At the seat of the puncture there is swelling and pain lasting for a week - a slight thickening of the part however may remain for several months.

Headache and general malaise.

Headache and a feeling of general Malaise is common.

Drowsiness.

In a large number of cases there was drowsiness, lasting for 1 to 2 days, being quite marked in some cases.

(4) Dr Clark's experience in the Hushiar-pur District.  
Fever.

Among 1,510 cases, only one man had a temperature of 105° F., and was ill very seriously for a week. He, however, recovered.

Among the remaining inoculated persons, in a large majority the Temperature did not rise above 102° F., and they were all free from fever within 48 hours.

Local reaction.

The local reaction gave trouble for 5 days longer - i.e., for 7 days altogether.

In one case an abscess appeared at the site of puncture.

In 5 cases there was severe urticaria within 2 hours after the inoculations: and disappeared within 24 hours. This urticaria was similar to that which occurs after inoculation with the Diphtheria anti-toxin.

Its value as  
a Prophylac-  
tic.

A. Professor Haffkine has summarised his conclusions regarding this Prophylactic as follows:-

(1) One injection of this prophylactic in full dose, i.e., 3 cc., is sufficient during an existing epidemic, and no repetition is needed.

(2) It has no effect on persons already diseased with plague; nor on those in whom the disease is about to, in a few hours, manifest its symptoms.

(3) It may possibly do good in persons in whom the disease is incubating, provided no more than 3 to 4 days have elapsed since the date of infection.

(4) The time needed for this prophylactic to produce its protective effects is shorter than in any other preventive treatment.

e.g. In Anti-Cholera inoculation	.	4 days.
" Vaccination against Smallpox	.	7 days.
"	Anthrax	. 12 days.
"	Rabies	. 15 days.
"	Plague	. 1 day.

(5) The length of the Protective period in plague is not known yet. It is necessary therefore to apply 2 to 3 inoculations in the course of a month.

(6) There remains fully the possibility of future experience compelling us to modify the above conclusions, though he (i.e., Professor Haffkine) is unable to abstain from expressing his hope that the general bearing of the results as above detailed will

remain unshaken - (Vide Indian Lancet page 129 for 1st February, 1897.)

B. Surgeon General Harvey has reported to the Government of India as follows - (Vide The Indian Lancet for June 1st, 1898).

M. Haffkine inoculates a person with the "serum" (?) of Plague Bacilli to confer on him a bactericidal power, which shall enable him to resist the Plague Bacillus in its natural form.

He goes further and strives to produce an anti-toxic effect in the tissues (by means of the toxines in his serum), which shall enable the patient to throw off the poison if it should gain access to his system and reduce the case mortality. He bases all this on a hypothetical consideration, and hopes that time and experiment will prove the validity of his conclusions.

So far the case mortality among the inoculated persons has not diminished - still the liability of inoculated persons to contract plague has been shown to have considerably diminished, and it may be stated that the chances of their escaping are 32 to 1, inasmuch as mortality amongst them is only a little more than 3 per cent. The following are the results of past experiments:-

1. In the Bombay house of correction, Plague

Extract from  
Surgeon Genl.  
Harvey's re-  
port on M.  
Haffkine's  
Prophylactic  
against  
Plague.  
(Vide the  
Indian Lan-  
cet for June  
1898.)



broke out towards the end of January 1897.

Inoculations were made on 148 prisoners on 30th January.

Of these 3 died on the same date. Previous to the time of inoculation there had been 12 cases, 9 of them having succumbed to the disease. Excluding these 15 cases and 12 deaths the results were as follows:-

Total No: of prisoners living under identically the same circumstances during the 8 subsequent days that the Plague epidemic lasted.		with			
		No.of cases	P.C.	Deaths	P.C.
321-	173 Noninocul <sup>d</sup>	12	or 6.94	6	or 3.49
	148 Inocul <sup>d</sup>	2	" 1.35	Nil	" Nil.

ii. In the Kolaba District amongst a population of 1,000 people there were 7 cases amongst the inoculated and they all recovered. Amongst the non-inoculated there were 26 cases; of these 24 died.

iii. In Lower Damaon there was a severe epidemic in 1896 - 97. Here 2,197 persons were inoculated and 6,033 remained non-inoculated. Between the end of March and the end of May 1897 there died 1,482 persons from amongst the non-inoculated; whereas from amongst the inoculated only 36 died. Had the latter (the inoculated) died at the same rate as the former (non-inoculated), there would have been 332 deaths amongst them instead of only 36 as stated above.

iv. At Lanauli in July 1897 M. Haffkine inoculated 323 persons who were living in 2 barracks under exactly the same circumstances along with 377 others who remained non-inoculated. The infection in this community was a very severe one. The former had only 14 cases with 7 deaths; whereas the latter had 78 cases with 58 deaths. At the latter rate there would have been among the inoculated 67 cases with 49 deaths. Here the reduction of mortality was 86 per cent.

v. At Kirkee in Autumn of 1897 plague broke out amongst the followers of the Royal Artillery. They numbered in all 1,530 souls living in 40 barracks.

Of these 671 were inoculated, 859 remaining non-inoculated. But the former lived among the latter under the same roofs, having the same food and the same drinks, etc. They were all subject to the same preventive measures alike. And yet among the former (the inoculated) there were only 32 cases with 17 deaths; whereas among the latter there were 143 cases with 78 deaths. Had the two suffered alike there would have been among the former 112 cases with 57 deaths. There was a saving here of 27.9 per cent.

vi. At the Umardji Jail Bombay, plague broke out in January 1898. Half the inmates had been previously inoculated.

On January 1st the number of prisoners was as follows:-

Non-inoculated 203

Inoculated 134

Amongst the former occurred 10 cases in January.

Among the latter there have been only 3 suspicious cases - viz:-

On 10th February,	1	} All recovered.
" 28th "	1	
and " 18th March	1	

But these 3 cases, it must be noted, the Medical Officer of the Parel Hospital did not consider plague cases at all. One of them had both parotids swelled and was probably a case of Mumps only.

vii. At Undera near Baroda plague broke out in January 1898. On 5th February the census was taken and the population found to be 1,029. By 14th February (inclusive) 79 of them had died of plague, leaving a balance of 950 persons.

Of these 513 were inoculated on 12th February. They were selected out of each sex, age and family in the place.

The remaining 437 remained non-inoculated. All were however subjected to similar sanitary precautions.



Between the 12th (the date of inoculation) and the 14th February (inclusive) there were 3 deaths in this community from plague among the non-inoculated. There were also 2 other deaths, but from other causes. Eliminating these 5 deaths from our calculations the results up to the 2nd of April were as follows:- (It must be noted however, that after the 26th of March, there were no more cases of plague).

1. Plague occurred in 29 families all under similar circumstances, except 1 circumstance that some were inoculated and others were not.

These 29 families consisted of 135 persons,  
 being      Inoculated              75  
              Non-inoculated        64.

The former had 8 cases with 3 deaths.

The latter " 28 cases " 26 "

The former would have had at the latter rate, 29 deaths instead of 3. There was thus a saving of 26 lives or reduction in mortality by 89.65 per cent.

Taking the whole number of inoculated (513) there were among them 8 cases (or 1.56 per cent) and 3 deaths (or 0.58 per cent).

The total number of non-inoculated being 437 and cases 28 and deaths 26, we may say 6.4. per cent were attacked and 5.9 per cent died - that is to say ten times as many as the Inoculated number.

2. Again let us look at the results as regards the individual families affected.

(a) In Hut 84, Ward 4, there were 10 persons living  
being Inoculated 5.

Non-inoculated 5.

There were two attacks here, both amongst the  
Non-inoculated.

(b) In Hut 18, Ward 4, there were 5 persons, being  
Inoculated 3.

Non-inoculated 2.

The latter were both attacked and died.

(c) In Hut 26, Ward 4, there were 3 persons living,  
being Inoculated 1.

Non-inoculated 2.

The latter were both attacked and died.

(d) In Hut 8, Ward 1, there lived 5 persons.

Inoculated 4.

Non-inoculated 1.

The former escaped, but the latter was attacked  
and died.

(e) In Hut 24, Ward 2, there lived 2 persons,

Inoculated 1.

Non-inoculated 1.

The former escaped, but the latter was attacked  
and died.

(f) In Hut 20, Ward 3, there were 7 persons.

Inoculated 3.

Non-inoculated 4.

In both there was 1 attack each, but the former survived, whereas the latter died.

(g) In only 2 Huts, fatal cases occurred among the Inoculated.

(h) In only 1 Hut an Inoculated person was attacked and died, while the Non-inoculated one escaped free. This happened in Hut 31, Ward 41, which had 6 persons living in it, being Inoculated 4.

Non-inoculated 2.

One of the former was attacked and died. The 2 Non-inoculated ones escaped altogether.

viii. The Suleman Muhammadans at Baroda, a population of 404 persons, living in very dirty and crowded quarters, had 332 persons inoculated. No Plague occurred among them.

ix. The Khoja community of Bombay, numbering several thousands had many\* persons inoculated: and only some 20 persons have suffered from Plague in that community.

Of the inoculated (who were several thousands), only 3 or 4 have died.

600 followers of His Highness the Agha Sahib were inoculated and none of them have been attacked with Plague, although they were freely moving about in and out among the infected people.

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\* 5,184 by the end of April, 1898.



x. Many persons were inoculated during the first Epidemic both at Bombay and Poona. Most of them escaped during its second recrudescence, the exceptions being very few.

xi. The above figures show that inoculation, although not an absolute protection either against seizure or death, is of immense value, both as a prophylactic and as modifying the severity of the disease and reducing the case mortality. This was 37.5 per cent among the inoculated, as against 92.85 per cent in the uninoculated.

C. Dr James received from Professor Haffkine from time to time his Anti-plague Medium and inoculated (with the help of several other medical officers on Plague duty, namely Drs. Wilkinson, Hunter, Clark and others including myself) 3,918 persons of different ages and sexes and castes during 1897 - 98 in 51 plague infected villages during the Epidemic.

Of these only 8 were attacked with Plague, of whom one died.

The one that died, her history is as follows:-

Khemi, a female, aged 40 years was inoculated on 5th April 1898 at Bunga, receiving only 1 cc. of the Anti-plague Medium. She had no reactionary fever and was therefore not protected. Ten days later, i.e., on 15th April, she was attacked with

Extract from  
Dr James'  
report on  
Plague in  
the Panjab  
1897-98 giv-  
ing the re-  
sults of  
Anti-plague  
inoculations  
by Professor  
Haffkine's  
Anti-plague  
Medium.

plague and died on 21st idem. Her case therefore should be eliminated from our number of inoculated and protected.

In her village 134 other persons were inoculated and of them only one was attacked, i.e., 0.74 per cent were attacked among the inoculated. On the other hand there were 1,357 uninoculated persons. Among them 42 were attacked with Plague, i.e., 3.094 per cent.

Again at the village of Bunga 870 persons were inoculated. Of these 6 were attacked with Plague, all mildly and none died. The per centage of attacked here was 0.693 among the inoculated.

Among the Non-inoculated (4917) there were 103 cases of Plague, of whom 65 died. The per centage of attacks among them was 2.18 and of deaths 63.0

The history of 81 families in this village is interesting, as they were carefully watched and their members lived in huts under exactly similar circumstances. They (i.e., these 81 families) were all severely infected with Plague and inoculations were performed among them with very good results. The following is a detailed list of these families:-

TABLE SHOWING THE NUMBER OF PERSONS  
INOCULATED AND UNINOCULATED IN EACH OF THE  
HOUSES ATTACKED WITH PLAGUE IN BUNGA TOWN  
DURING 1897 - 98.

Serial Number	Inoculated persons in the family.				Uninoculated persons in the family.				Remarks.
	Unattacked	Attacked but recovered	Attacked and died.	Total.	Unattacked	Attacked but recovered.	Attacked and died.	Total.	
1	2	1	-	3	-	-	2	2	
2	2	-	-	2	4	-	4	8	
3	1	-	-	1	-	-	3	3	
4	-	-	-	-	-	-	1	1	
5	2	-	-	2	1	-	1	2	
6	5	-	-	5	6	-	1	7	
7	-	-	-	-	3	1	1	5	
8	2	1	-	3	-	-	-	-	
9	1	-	-	1	3	1	1	5	
10	-	-	-	-	1	1	-	2	
11	-	1	-	1	1	-	2	3	
12	-	1	-	1	2	-	1	3	
13	-	-	-	-	1	1	1	3	
14	1	-	-	1	3	1	-	4	
15	-	-	-	-	2	1	-	3	
16	4	1	-	5	3	1	1	5	
17	1	1	-	2	1	1	1	3	
18	-	-	1	-	3	1	-	4	
19	-	-	-	-	1	1	1	3	
20	-	-	-	-	1	1	-	2	
21	-	-	-	-	-	3	1	4	
22	3	-	-	3	2	1	-	3	
23	2	-	-	2	2	1	-	3	
24	-	-	-	-	1	1	-	2	
25	-	-	-	-	-	-	2	2	
26	-	-	-	-	4	1	-	5	
27	1	-	-	1	2	2	-	4	
28	-	-	-	-	6	1	-	7	
29	-	-	-	-	-	1	-	1	
30	6	-	-	6	1	1	-	2	
31	3	-	-	3	3	-	1	4	
32	-	-	-	-	1	1	3	5	
33	3	-	-	3	3	-	1	4	
34	1	-	-	1	8	1	1	10	
35	-	-	-	-	5	-	-	5	





"The following interesting figures are obtained from this statement.

74 or a little over 20 per cent of the 2 camps were inoculated. Among these 6 were attacked with Plague, - mildly, and all recovered.

Of the uninoculated people 97 out of 281 were attacked and of these 65 died.

Comparing the results by per centages we get the following figures:-

(1) Inoculated - 8<sup>1</sup>/<sub>108</sub> per cent attacked.

Mortality Nil.

(2) Uninoculated 34<sup>5</sup>/<sub>51</sub> per cent attacked.

Mortality 67 per cent.

The difference of the figures is very large, and as the inoculated persons were living and had lived throughout the Epidemic, in exactly the same conditions as the uninoculated ones, - first in their houses and afterwards in the camps, and with the same sources and chances of infection, the difference appears to be due to something more than an accident. In fact it points to the efficacy of the inoculations."

(3) The details of the 6 Inoculated persons who were attacked with Plague are the following:-

1. Bishan Das - aet 12 yrs - inoculated on 25<sup>3</sup>/<sub>78</sub> with 1<sup>1</sup>/<sub>4</sub> cc. of standard strength.

He was attacked with Plague at 10 p.m. on March 31st., 6 days later - mild attack and recovered.

Total Inoculated in the family 2 - (1 attacked - recovered).

Total Uninoculated in the family 3 - (2 attacked - both died).

- ii. Lachman Das - aet. 14 yrs. - inoculated with  $\frac{3}{4}$  cc. on 20<sup>3</sup>/<sub>3</sub> - was attacked on 21st April (after 1 month) Attack mild - recovered.

Total Inoculated in the family 3 - (1 attacked - recovered).

Total Uninoculated in the family - Nil.

- iii. Pala - aet. 35 yrs. - inoculated with  $2\frac{1}{2}$  cc. on April 16th 1898. He was attacked on 24th April (8 days after inoculation) - mild attack - recovered.

Total Inoculated in the family 1 - (attacked - recovered).

Total Uninoculated in the family - Nil.

- iv. Ahmad Faruq - aet. - 12 yrs. - inoculated with  $1\frac{1}{2}$  cc. (in 2 doses) on March 22nd 1 cc.  
" " 25th  $1\frac{1}{2}$  cc.

He was attacked on 25th April (1 month after last inoculation). Mild attack. Recovered.

Total number Inoculated in the family 2 - (1 attack - recovery).

Total number Uninoculated in the family 3 - (attacked 2 - both died).



- v. Ganga Ram - aet. 22 yrs. inoculated with  $1\frac{1}{4}$  cc. on March 20th. He was attacked on April 25th (35 days after inoculation).

Mild attack - Recovery.

Total number of inoculated in the family 1 - (attacked and recovered).

Total number of Non-inoculated in the family 8 - (attacked 3 - all died).

- vi. Nathu Ram - aet. 19 yrs. - inoculated with 2 cc. on March 24th. He was attacked on May 3rd (40 days after inoculation). Mild attack - Recovered.

Total number of Inoculated in the family 2 - (1 attacked-recovered).

Total number of Non-inoculated in the family 3 - (2 attacked - 1 died and 1 recovered).

The history of the above six cases shows that "all the six protected cases recovered, while only one out of the nine unprotected cases survived the attack."

"The difference in the nature of the disease was also most marked in hospital among the inoculated persons. The symptoms set in in the usual way with sudden fever, headache, vomiting and early prostration, and the disease looked like an ordinary case of Plague. But after a day or two, the symptoms suddenly ceased, the temperature fell to normal, the mind cleared up and the patient became convalescent

much earlier than usual. The gland in these people, in every case except one, re-absorbed without supuration. Bishan Das, who had a large axillary bubo, was the worst case. He had 11 days' fever; Ganga Ram 8; Nathu 4; Ahmad Faruq 3; Lachman Das 2; and Pala only 1 day's fever."

"The only other case of Plague which occurred among inoculated persons was at Pharala. There were 99 men employed on disinfecting - all inoculated. Only one of them suffered, but his attack was mild and he recovered."

"To sum up, there have been 2,408 persons inoculated in the Jullandhar District, 193 being inoculated twice. There have been 8 cases of Plague among the inoculated with 1 death. In the fatal case, the dose was small, and no reaction had followed the Operation."

The remaining 1,510 were done in the Hushiarpur District. Of these 964 were employed on disinfection work in 6 villages. None of these 1,510 were attacked with Plague, although so many of them were seriously exposed to infection. Of the non-inoculated members of the disinfection gangs some were attacked and died.

D. At Dharwar the results of inoculations may be judged from the following, showing that second inoculation reduces still further the risk of Plague infection:-

Results of  
Inoculations  
at Dharwar.

	Present Population	Total No: of attacks	Total No: of deaths among those attacked.
Once inoculated	3074	106	37
Twice       "	3557	17	4
Uninoculated	3089	1118	879

(Vide London Lancet, page 1667, dated 17th December 1898.)

(2) Mercury  
as a Propy-  
lactic.

It was the common experience of all the attendants, etc., attached to the Plague Hospital at Birampur, that although they were continually washing their hands and faces with corrosive sublimate solution and had done so for days together, yet they never suffered from Ptyalism in the least degree.

With this observation I linked the fact that plague patients placed under the influence of mercury did not suffer from Ptyalism either, although as much as half to two drachms of the Liq. Hydrarg. perchloride was being administered to them every sixth hour.

This led me to suppose that mercury possessed some prophylactic power against an attack of plague, especially as none of the Birampur Attendants suffered from plague.

I wanted to experiment with this drug by



administering it daily to all present in the segregation camp. Unfortunately most of them declined to take this medicine, saying they were perfectly well and were not going to be experimented upon.

I succeeded, however, in persuading six persons to take this drug. They yielded because two of them belonged to a family in which there had been four deaths within ten days: and the rest belonged to a second family in which there had been eight deaths. They were greatly frightened, and it was feared that their fate was also doomed.

They were all placed in one hut together and were given half a drachm of the Liquor twice daily for three weeks.

None of them salivated at all and they all escaped plague.

I mention this unfinished experiment, simply for what it is worth, and not because it proves anything.

According to Dr Thomson's test, referred to above, all these six persons probably had the plague poison in their systems, because they were members of families severely infected, and because when given mercury they did not salivate.

On the other hand, I must note that they were all placed under the most favourable circumstances to escape infection. They were thoroughly disinfected and segregated in new huts. All their clothes they had on them at home, were burned and new ones supplied them. Their new huts were well ventilated.

Then in the next place, having been exposed to the poison of plague for many days in their homes, they had perhaps become immuned by auto-inoculation.

It is for these two reasons chiefly, that my experiment proves nothing. Still it is a point which should be gone into, for of this there is no doubt, that there is some very definite relation of antagonism between Mercury and the Toxines produced by the Bacillus of Plague. The Mercury forms some compound with the Toxine albuminoid and loses its salivating effect.

XVI. Sanitary Measures.

Sanitary measures which should be adopted when plague threatens to break out in a locality and when it is present in a Community.

They are based on our knowledge hitherto gained in connection with all other epidemic diseases which have been investigated.

That plague is a contagious disease, has been known for long, but that it is not an infectious disease in the general sense, has been fully proved during its recent outbreaks in Southern China and India. It is not infectious in the open air. Open air dilutes, attenuates and kills the poison of plague. It is infectious, however, inside, in an infected room, the air of which is close and shut in.

In considering these measures, we must also remember that the poison of plague is spread both by men, rats, and several other animals. The chief spreaders however, are men and rats; the former from house to house and village to village, and the latter from one house into another adjoining it, or very near it.

We must also remember that the incubation period of plague is from a few hours to eight days in Pestis Major, and much longer in Pestis Minor.

Then there is this important point worth keeping in mind, that heat above 110° F. kills Plague Bacilli: and that they are killed in a few minutes by acids, by Phenyle, Chlorinated Lime, and by a solution of fresh unslaked lime.

We shall now state these sanitary measures under two heads:-



- (1) Those connected with the Patient,  
and (2) Those connected with the General Public.

(1) Measures connected with the Patient.

Every Patient must be provided with spittoons, etc., which should be kept a quarter filled with 1 in 1000 mercury lotion, near the bed.

All excreta should be received into vessels similarly kept quarter filled with the same germicide. They should be buried at least one and a half feet under ground.

The bodies of plague patients should be buried six feet under ground, wrapped up in soaking wet mercury lotion. Those that can be burned, should be burned.

The clothes, etc., worn by plague patients, if possible, should be burned at once.

The Patient.

The Plague Patient with all his attendants should be segregated.

His attendants.

The patients must be provided with separate well ventilated Plague Hospitals and their attendants placed in segregation camps near the plague hospital. This is in order that they may be able to look after their sick properly and conveniently. All persons on admission to the segregation camp, must be thoroughly disinfected.

His clothes.

Their clothes, etc., should be boiled and their bodies washed with mercury or carbolic lotion, the former 1 in 1000 and the latter 1 in 40. In the Hushiarpur District we used Phenyle Baths of 1 in 200 strength.

The infected house.

The infected houses must be at once white-washed and their floors burned, when they are mud floors, or saturated with 1 in 1000 mercury lotion. The lime used in white washing should be either fresh unslaked lime or chlorinated lime. All property in infected houses should be soaked with 1 in 1000 mercury lotion or subjected to 150° F. heat in hot air-chambers, according to circumstances.

Indian Towns and Villages are infested with rats and mice which spread the disease from house to house, the houses in them being connected by common roofs and walls. The rats of one house can easily go into another through holes in their mud walls and grass roofs. That infection does spread in this way has been proved to demonstration in the Hushiarpur and Jullandhar Districts. (Vide Dr James' account, referred to above under head Actiology.)

It is advisable therefore to break up all house connections with infected houses. This

was done at Rampur Bilron, in February 1898, during the first epidemic there, when I was in charge, with the result that the epidemic was completely cut short.

The roofs of infected houses must be taken down and their grass burned, in the case of grass roofs - the timber can simply be singed through the fire. This was done in the village of Jandiala with the very first case in the Hushiarpur District, and an epidemic of plague prevented.

Other houses  
in the in-  
fected block.

All the houses in an infected block must be thoroughly disinfected, even when no cases have occurred among them. This precaution is necessary owing to the possibility of rats, etc., having carried the infection to them. This was done in almost every village that was infected in the Panjab in 1897-98, with the result that the plague poison has been completely destroyed from those villages.

## (2) Measures necessary for the General Public.

As far as possible all parts of towns and villages should be kept clean and free from manure heaps, etc. In Indian villages the outlying houses are surrounded by manure heaps, and the village lanes have mud drains carrying the



spill water of houses. They should all be kept thoroughly clean.

It was found to be a cheap method in the Hushiarpur District to sprinkle fresh unslaked lime in these drains.

As the manure heaps could not be removed, they were simply buried over with dry earth to the depth of nine inches to a foot.

Badly ventilated houses should be provided with a sufficient number of ventilators.

In the Hushiarpur District most of the village houses being mud walled and grass roofed, large holes were opened out in them quite easily for the purpose.

The inhabitants of all infected villages should not be allowed to go and visit other villages.

This is a state measure and can only be enforced by law: and yet it is one in which if the people themselves do not help it can never be carried out completely. On the whole the people of the Panjab did submit to such a measure, with the result that plague has practically died out within a year, and was kept confined to a very small area, i.e., an area which consisted of two small adjoining divisions of the Hushiarpur

and Jullandhar Districts, attacking in all some eightysix villages.

The second great measure in which the people must help is to establish Quarantine posts outside each non-infected village or town in an infected country. All persons on arrival from an infected village or town, or their immediate vicinity, should be placed in quarantine for eight days, and carefully watched. They should be disinfected immediately on arrival at the quarantine post, as well as on the day of their discharge from it.

This was done systematically in the villages of the Hushiarpur District, which were under my care. The people were very good and patient, although extremely ignorant. They were very much connected by blood relationship, etc., with people in infected villages. Yet most of them took the warning from the Government officials. The result has been as good as could be expected. In our District there were only sixteen out of nearly four hundred threatened villages, actually infected; whereas in the Jullandhar District, where the people did not take these precautions in time, there were over seventy villages infected.

D. H. P. Datta